

**Addis Ababa University**

**Graduate Programme**



**Survey on pests of honey bees (*Apis mellifera* L.) in private Apiaries  
in Addis Ababa**

**By**

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## **Abbreviations**

AFB American foul brood

EFB European foul brood

SB Sac brood

CB Chalk brood

N/S/L Nifas silk lafto

## **Abstract**

*The honey bee (Apis mellifera L.) is one sub species able to survive in a wide range of climates and environments, occupying every continent of the world except Antarctica. They have several natural enemies which disturb the colony, can cause death and absconding of the colony and also damage products (honey and wax ).This survey was made in Addis Ababa to detect the occurrence of those enemies, determine their distribution and generate information on the prevention and control methods. Laboratory and field diagnosis was conducted and the apiaries were visually examined for the presence of pests. About 100 beekeepers were involved in the survey for honey bee pests and predators and laboratory diagnosis has been conducted on 50 samples of adult honey bees and 20 samples of brood to identify honey bee diseases. The field diagnosis indicated that ants attacked 30.8% of the colony, and 10.07% of the colonies were found infected by wax moth, 13.8% of the colonies were attacked by spider, the “bee eater birds” attacked 14.3% of the bee colonies. The laboratory diagnosis showed that 100% positive for the adult honey bee diseases nosema and amoeba in all examined samples. It is also identified on this diagnosis that the mite pest varroa also attacked the adult and brood bee colonies. The result obtained from this study in some aspects is the same with that of Desalegn and Yosef (2005). Generally the sector in the city has challenging pests which disturb the colony and damage their product. There for it is always better and easier to protect colonies of bees from any damage caused by pests than cure after been exposed. Good sanitation, regular inspection of the food and water and strong quarantine on imported used bee equipments are some of the ways which are important to control pests.*

**Key words** honey bee diseases, honey bee pests, honey bee parasites, honey bee predators, brood diseases and brood parasites.

# 1. INTRODUCTION

Honey bees are social insects, living socially in colonies. There are three castes which are the queen, the workers and the drone. The queen and the workers are females but the queen is fertile while the workers are sterile and drones are male bees. There is division of labor among the workers in the hive but the queen is responsible only to lay eggs and the drone mates with the queen during marriage flight and die. Colonies of bees are formed by swarms, a queen with hundreds of workers. Individual colonies may contain tens of thousands of honey bees. Each colony contains thousands of worker bees which have division of labor among them. The honey bee (*Apis mellifera* L.) is one sub species able to survive in a wide range of climates and environments, occupying every continent of the world except Antarctica. This makes them one of the most successful organisms in the planet. Besides their production of honey and bees wax, honey bees play very important role in the environment by pollinating flowers (wild and many agricultural crops) when they feed upon nectar and pollen (Gezahegn, 2001).

The spread of honey bees is accompanied with honey bee insect or mite pests. On the other hand, over the past few decades, as technology makes transport easier and lower national barriers to trade, which increase international trade in bees and bee products, contribute for the spread of bee pests throughout the world. If pests once occur in the colony, spread very quickly and will be difficult to treat, there for can cause total or partial loss of the colony (FAO, 2006).

Because of the social behaviors of honey bees, many thousands of individual bees living together, which will increase the frequency of contact among themselves, their sharing and orally passing of food among members of the hive and the widely distributing of hormones and pheromones among the colony and other social behaviors which will have great contribution whenever a pest is present in the colony it will be spread with great ease. The hygienic behavior

of honey bees is very important to protect the colony from insect and mite pests. The bees inspect each single brood cell, remove the cell capping and sick brood is removed from the colony.

Even if adult bees fall ill they are either forced to leave the colony or are lost during the first foraging flight. Despite these very effective defense mechanisms bee colonies face problems due to diseases, parasites and distractive insects (Gezahegn. and Amasalu., 1991). With increased globalization diseases, parasites and pests may spread by migration, sale of colonies and bee equipments. It is so important for bee keepers to know the world's distribution of honey bee diseases, pests and predators. It is known that all bee keepers need to maintain healthy and productive bee colonies and this can only be accomplished by reducing the frequency and prevalence of diseases within bee hives (Desalegn, 2001). As Ethiopia is one of the countries with huge colonies of honey bees, it is very important for the Ethiopian bee keepers to have the information about the distribution of honey bee diseases, pests and predators

## **1.1. Background**

The suitable climatic condition of Ethiopia allows growing of different vegetations and crops, which are good sources of forage and habitat for the existence of a number of other living organisms. The vegetation and crop of Ethiopia are also good sources of nectar and pollen for honey bees. The botanical resources of Ethiopia which is large and highly diverse combined with suitable climatic condition makes it perfect for the bee keeping business. For

Ethiopians who are small land holders, bee keeping has significant role in generating income.( Gezahegn, 2001)

Bee keeping activity was common by the Ethiopian farmers since 3500—3000 BC over centuries. Honey is used as food and medicine by the society and bee wax is exported to generate

foreign currency. This makes beekeeping a good business, which is one source of income by selling honey and bee wax. There are around 10 million bee colonies in Ethiopia, out of which about 5 to 7.5 million are estimated to be hived, the remaining exist in the wild. This is the largest bee population in Africa. It is estimated that there is 45,300 metric tone annual honey production in Ethiopia, which is the first in Africa and ninth in the world (MOARD, 2007; FAO 2010). Even if very large production of honey but is unattractive in appearance and is poorly managed, therefore its place in local market is taken by imported honey. Because of this the bee keepers in particular and the country in general are not benefiting from the sub sector (Dabessa and Belay, 2015).

Addis Ababa is the capital of Ethiopia as well as Africa. There are a number of diplomats and gusts who make their residence in Addis. Farther more there are a number of hotels, restaurants and resorts which host those diplomats and gusts. There for in the city there is high demand of honey to full fill the need. So honey is imported from different parts of the world to the city which creates opportunity for the introduction of diseases which they were previously unknown .There is also urban bee keeping in Addis, the bee keepers usually buy bee colonies, bee keeping equipments, bee products out of the city. This all creates opportunity for the spread of infections, which can also result in introduction of diseases in the city where they were previously unknown (Desalegn and Yosef, 2005).

It was expected that more than 1000 beekeepers are found in Addis Ababa but due to urbanization and other reasons most beekeepers stop their beekeeping activity. Now there are about 514 beekeepers in the city.This tremendous reduction in the number of beekeepers have several reasons, the most important reason is the beekeepers ( most are farmers) displaced from their land by investors, construction of high ways and building of condominium homes. Even if most beekeepers in the city agree that the sector is fruit full because of enough forage and

available water but their benefit is not to the maximum due to pests of honey bees and other management problems.

## **1.2. Statement of the problem**

There are around 514 bee keepers in Addis Ababa city. As Addis Ababa is the capital city of Africa, the city hosts a number of delegates who well come in the modern hotels of the city, restaurants and resorts. To satisfy the needs of those consumers the city import honey from different parts of the world, these honey can be used by the bee keepers of Addis Ababa for their bee colonies. Most bee keepers also use used bee keeping equipments obtained out of the city. The use of honey from unknown sources and the bee keeping equipments provide opportunity for the introduction and spread of infections to the city. The diseases of honey bees and the pests which attack the bees or their products are enemies for the beekeeping sub sector. Because the sub sector is not benefiting the bee keepers, the city and in general the country to the maximum of its potential. There for identification of the honey bee diseases and pests in the city, will provide information for the bee keepers and enable them to protect their bee colonies from the distractive pests.

### **1.3. Objectives**

#### **General objective**

To detect the occurrence, determine the distribution rate and generate information on the prevention and control of honey bee diseases and other enemies in Addis Ababa.

#### **Specific objectives**

- Detect the occurrence of honey bee diseases and pests in all the sub cities of Addis Ababa.
- To determine the distribution rate of honey bee diseases and pests in all the sub cities of Addis Ababa
- To generate information on the prevention and control of honey bee diseases and pests in Addis Ababa.

## 2. Literature Review

### 2.1. Diseases of honey bees

Honey bee colonies are susceptible to some viral, bacterial, fungal and protozoa diseases, which infect either the adult honey bee or the brood or both the adult and the brood. Based on this we will discuss the most common brood and adult diseases of honey bees as follows.

#### 2.1.1. Diseases of the brood

##### American foul brood ( AFB )

American foul brood is caused by spore forming bacteria called *Paeribacilles larvae*. The bacteria have slender rod structure which is slightly round at the ends and it can grow in chain. Produce oval shaped spores which are very resistant to disinfectants, extremes of heat and cold.(plate 1)

In each infected larvae about 2.5 billion spores are produced. The *P.larvae* spores can be detected in the hive products such as honey, pollen and bees wax. AFB is the most distractive and wide spread disease which affect the brood only. Adult bees are not susceptible to AFB. The spores of the bacteria are usually ingested mixing with food by the larvae and germinate in the gut where it multiplies. The spores of the bacteria can remain dormant for more than 50 years. The symptoms include uneven brood pattern, sunken concave capping, brown decomposing larvae. ( table 1) (plate 2)

The diseases can spread if combs, honey or hive equipments are transferred from AFB infected colony to a healthy colony. (Williams, 2015). The most effective way of preventing the spread of the disease is burning infected colonies and combs and sterilize the hive by scorching. (Williams, 2015). No AFB occurrence is recorded in Ethiopia (Haylegebriel, 2014).

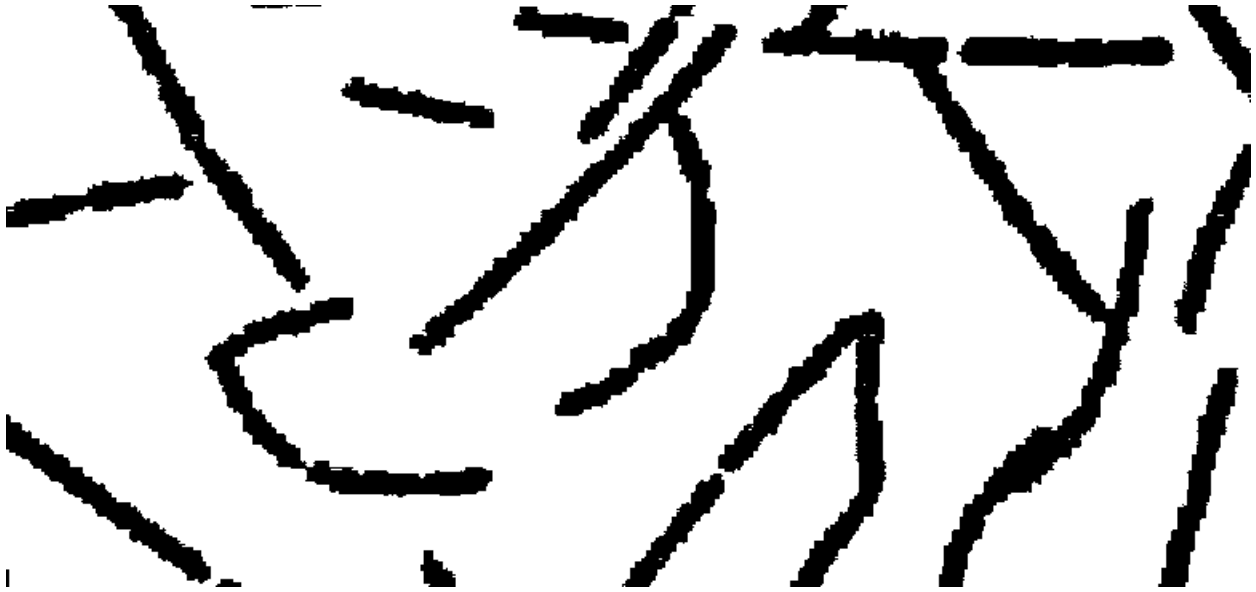


Plate 1. The bacterium that causes American Foul Brood (source: Shimanuk and David, 2000)



Plate 2. Stretched test for American Foul Brood; irregular pattern of sealed broods with sunken and punctured caps.( source: FAO, 2006)

### **European foul brood (EFB)**

European foul brood is less serious than EFB it is caused by the bacterium *Melissococcus plutonium*, which is short non sporing and lancet shaped can occur in pair, in chain and singly. The bacterium is swallowed by the larvae with contaminated food. Adult bees are not susceptible to EFB. It remains in the gut and do not invade other tissues of the larvae. The bacteria share the larvae nutrient and usually the larvae die due to starvation. The disease spreads through receiving the equipments, combs and honey from infected colonies to healthy and bees robbing honey from infected colonies also transmit the disease (Williams, 2015). The symptoms include uneven brood pattern, creamy white gut visible through the body wall, melted down, yellowy white larvae, loosely attached brown scales and an unpleasant sour odor. ( table 1) (plate 3)

Slightly infected colonies can be treated with antibiotics, but those colonies in severe cases must be destroyed by burning the infected colonies (Shimanuk and David, 2000). There is no any study which declares the occurrence of EFB in Ethiopia (Haylegebriel, 2014).



Plate 3. Larvae in coiled stage, killed by European *Foul Brood* (source: FAO, 2006)

### **Chalk brood**

It is caused by a fungus called *Ascosphaera apis*, which is a heterothallic organism. Spores of the fungus are swallowed with contaminated food or may also enter through the surface of the body. An affected larva becomes overgrown by fluffy, cotton-like mycelia and swells to the size of the brood cell. If there are many infected larvae in a hive, mummies can be found at the entrance of the hive or on the bottom boards. Sometimes mummies can be removed from brood cells by tapping the comb against a solid surface. This easy removal of larval remains can differentiate the chalk brood disease from other brood diseases (Shimanuk and David, 2000). The disease causes death and mummification of sealed brood of honey bees with consequent weakness of the colony. No recommended chemicals to control the disease, the hygienic behavior of the worker

bees, their ability to detect and remove mummies, and re-queening are good measures to control the spread of the disease (Williams, 2015). The disease is called chalk brood because the infected larvae usually dries into a hard, shrunken, white, chalk like mummy. (plate 4)

Adult bees are not susceptible to chalk brood. In Ethiopia the survey on chalk brood disease was started in the year 2000, and the existence of the disease was reported in 2001, around the Holeta research area (Haylegebriel, 2014)



Plate 4. Brood killed by chalk brood; white and black mummies (source: FAO, 2006)

### **Sac brood**

Sac brood is a viral infection caused by the virus called *Morator aetotulas*. It is the only brood disease caused by virus. Usually the larvae infected by this disease is free from bacteria, this can

be used as laboratory verification besides the other gross symptoms of the disease. Affected larva changed from pearly white to gray and finally black. The infected larvae is usually found in capped cells and the head development of those larvae is retarded and is usually darker than the rest of the body ( table 1). When the infected larvae is carefully removed from their cells, they appear to be a sac filled with water that is why the disease is called sac brood.(plate 5)

Adult bees are not susceptible to sac brood (Shimmanuk and David, 2000)



Plate 5. Bee larvae killed by sac brood disease (source: FAO 2006)

### **Stone brood**

The disease is caused by fungus. The most common fungus which causes the disease are;

*Aspergillus flavus*, *Asparigillus fumigates* and sometimes other *aspergillus* species. It is difficult

to identify the disease during its early stages of infection. Within the infected larvae the fungus grows rapidly and forms a whitish- yellow collar like ring near the head end of the infected larvae .The disease is called stone brood because after the larva die of the disease, it becomes very hard and quite difficult to crush. (Shimanuk and David, 2000 )

Table 1. Comparative system of various brood diseases ( source: Shimanuk and David 2000)

Symptoms	American foul brood	European foul brood	Sac brood	Chalk brood
Appearance of brood comb	Sealed brood, sunken, discolored, or punctured capping.	Usually unsealed broods, sealed broods discolored, sunken or punctured capping.	Sealed brood, scattered cells with punctured capping.	Sealed and unsealed brood
Age of dead brood	Usually younger pupae or older sealed larvae	Usually young unsealed larvae; occasionally older sealed larvae	Usually older sealed larvae; occasionally young unsealed larvae.	Usually older larvae.
Color of dead brood	Dull white, becoming light brown, coffee brown to dark brown, or black.	Dull white, becoming yellowish white to brown, dark brown	Grayish or straw colored, becoming brown, grayish or black,	Chalk white. Some times mottled with black spots.
Consistency of dead brood	Soft, becoming sticky to ropy.	Watery; rarely sticky or ropy.	tough skin forms a sac.	Watery to paste like
Odor of dead brood	Slight to pronounced odor.	Slightly sour penetratingly sour.	None to slightly sour.	Slight none objection able.
Scale characteristic	Uniformly lies flat on lower side of cell. Adheres tightly to cell wall, fine thread like tongue of dead pupae may be present. Head lies flat.	Usually twisted in cell, does not adhere tightly to cell wall.	Head prominently curled toward center of cell. Does not adhere tightly to cell wall, rough texture, brittle, black.	Does not adhere to cell wall. Brittle, chalky white, mottled, or even black.

## 2.1.2. Diseases of adult honey bees

### **Nosema**

Nosema is caused by the protozoa called *Nosema apis*. It is the most damaging disease of adult honey bees. The transmission is by the ingestion of the protozoa spore with contaminated food. The pathogen produces large and oval shaped spore. The spores germinate in the mid gut, multiply and penetrate the gut wall forming new spores which infect new gut cells and can also be defecated. There is no reliable field diagnostic symptoms but in severe cases of infection, it is some times possible to separate healthy from diseased bees, the abdomen of an infected workers often appears to be swollen and shiny. Diagnosis can be made only by microscopic examination of suspected bees or their fecal material for the spores.

. (Shimanuk and David, 2000 ) Control of the disease is possible by keeping the colony strong, removing possible causes of stress, adequate ventilation protection from cold and humidity. Bee keepers can control the disease.(FAO, 2006)

### **Amoeba**

Is caused by a single cell parasite called *Malpighamoeba mellifica*. The parasite affects the malpighian tubules of the adult honey bee. The disease shorten the life cycle of bees. The disease is transmitted by feeding on contaminate food of honey bees. Diagnosis can be made only by removing and microscopically examining the tubules for the presence of amoeba cysts. The disease is common in Ethiopia including Addis Ababa with high prevalence rate

( Haylegebriel, 2014).

## **Varroa mite pests**

Mites are the most serious parasites of *Apis mellifera*, have dorsa ventrally flattened body covered with short hairs and are reddish brown in color. The adult female mite are oval and flat, about 1.1mm long and 1.5mm wide can easily be seen with necked eye, male mites are relatively smaller. Mites can be found in the adult honey bee, the brood and hive debris ( plate 6 and plate 7) . It is external parasite which attaches itself to the adult honey bee between the abdominal segments or between body regions ( head, thorax and abdomen ) which is difficult to detect them, but they can be seen easily against the white surface of pupa. They feed upon the hemolymph of adult bees, larvae and pupae which causes injury on the honey bee. The mites prefer drone broods to worker broods (Shimanuk and David, 2000). Pupa may not develop to adult bees if the infestation is heavy, adults that do emerge may have Shorten abdomen, deformed wings and disturbed behavior are common symptoms. Reduction in adult bee population, evacuation of hive by crawling adult bees and individual larva appear twisted in the brood cell are also syndromes of the colony with heavy infestation. The mites may act as vector for a virus so, can introduce a virus to the pupa during feeding, usually the virus causes misshaped wings and the parasite shorten the life cycle of the honey bees. ( FAO ,2006)



Plate 6 *varroa* species in adult worker bees ( source: Holeta Bee Research Center 2016)

Plate 7. *varroa* species in brood

(source; Holeta Bee Research Center 2016)



### Tracheal mite pests ( Acarapidosis )

Acarapidosis is caused by a very small mite called *Acarapis woodi* that lives and breeds within the thoracic tracheae of adult bees, all the three casts of the adult bees ( queen, worker and drone) are equally susceptible to the attacks (plate 8). The disease have no reliable typical visible symptoms of infestation. The most reliable diagnosis method is laboratory dissection. The disease shortens the life span of the individual bees (Shimanuk and David, 2000).

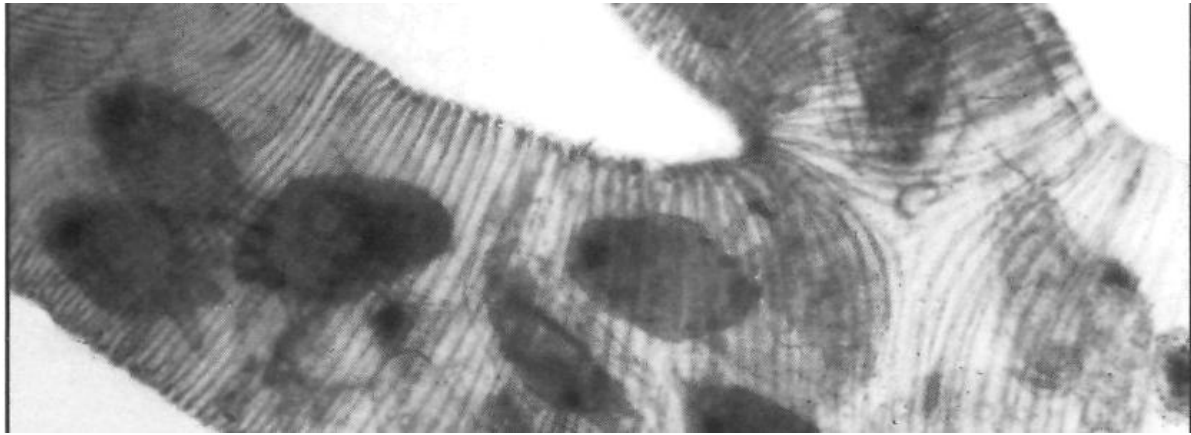


plate 8 Adult honey bee tracheal contain mites (source Shimanuk and David 2000)

## 2.2. Pests of honey bees

There are several pests which are the enemies of honey bees and which destroy their products. According to Desalegn Begna(2015) there are as more than 15 honey bee pests identified in Ethiopia at different times. Ants, wax moth, wasps, beetles, bee lice, lizards, spiders, birds, mice, pseudo scorpions, prey mantis are honey bee pests registered locally. Ants, small hive beetles, wax moth and spider cause the greatest distraction on the honey bee colonies than any other pests.

### 2.2.1. Small hive beetle

The beetle *Aethina tumida* is called the small hive beetle. An adult small hive beetle is about ¼ inch long, which is approximately 1/3 of the length of an adult worker bee and have a reddish brown color ( plate 9). It can live and multiply within the bee colonies or outside bee colonies. The eggs are laid in empty cells and are about half the size of honey bee eggs. To develop from egg to adult the period of time which takes for the beetle is at least four to five weeks. The larvae of small hive beetle usually prefer to live on or in pollen and honey combs and feeds upon brood, pollen and honey (plate 10). Bee brood and honey combs can be infested by the beetle and their larvae. They usually destroy cell caps by forming eating canals through (Desalegn, 2001). They cause fermentation of honey, their larvae and faeces change the color and taste of the honey and cause mucilaginous appearance of combs. Keeping the colony stronger is the best way to protect the colony against infestation. (Shimanuk and David, 2000)



Plate 9 Small hive beetle (source: FAO 2006)

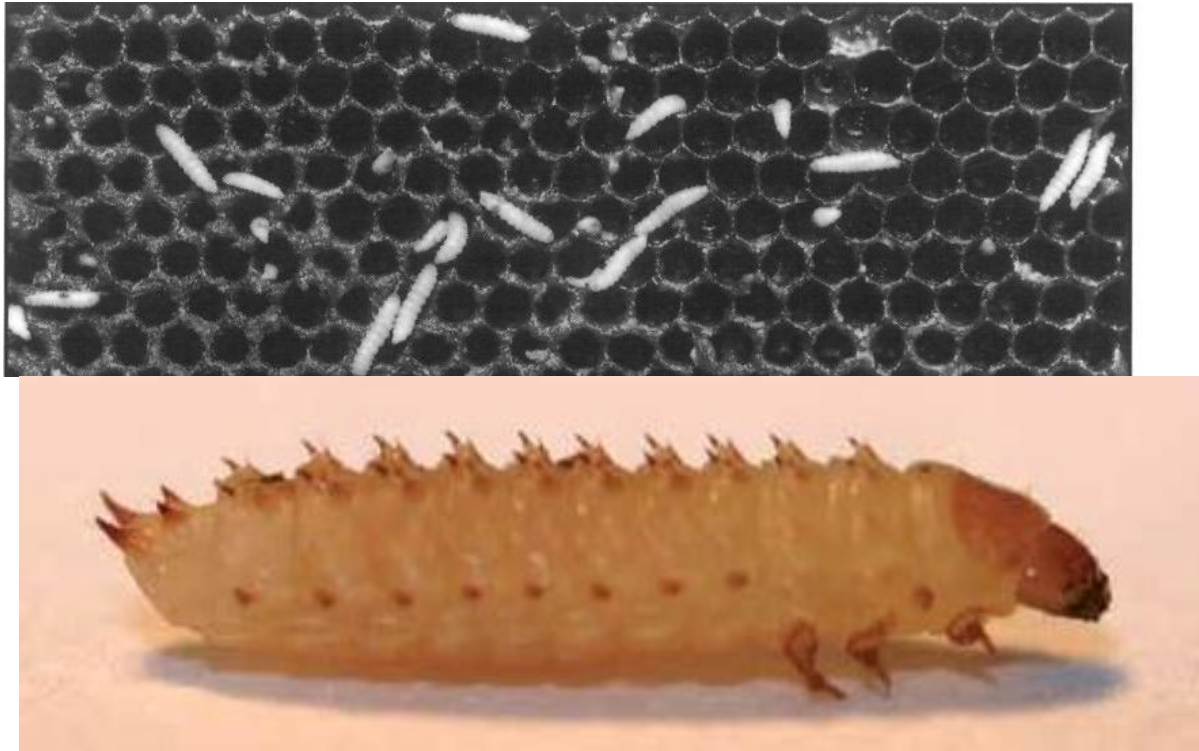


Plate 10 Small hive beetle larvae (source: FAO 2006)

### 2.2.2. Wax moth

The most serious pests of honey combs are the greater wax moth (*Galleria mellonella*) (plate 11) and the lesser wax moth (*Achroia grisella*) (plate 12). The Mediterranean flour moth (*Anagasta kuehniella*) can also cause comb damage. The warm temperature in tropic and sub-tropic favors their rapid development. Cracks and places between the wooden parts of the hive are good sites for the female greater wax moth to lay clusters of eggs and the larval stage of the moth is the destructive stage. It feeds up on honey, cast-off pupal skins, pollen and other impurities found in bees wax, but not from the beeswax, itself (plate 13). Older combs are more likely to be damaged by moths than new combs or foundations. (Shimanuk and David, 2000).

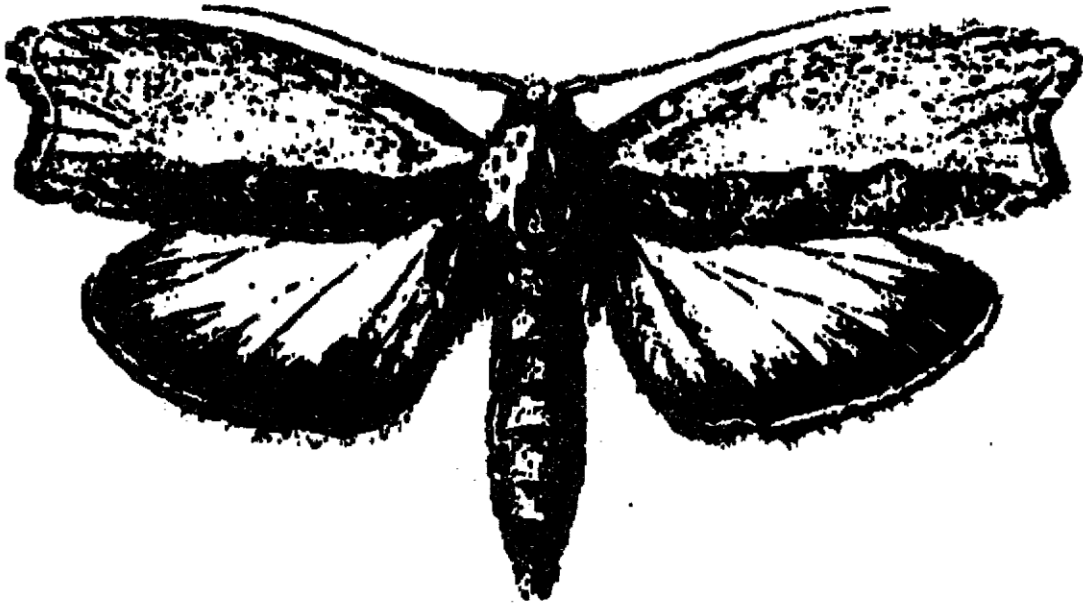


Plate 11 greater wax moth; *Galleria mellonella* (source: Shimanuk and David 2000)

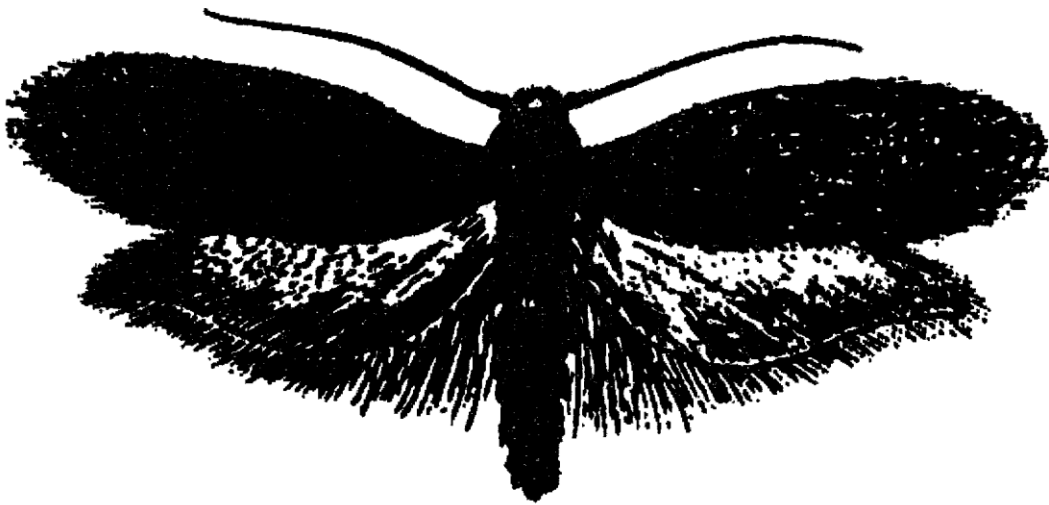


Plate 12. lesser wax moth; *Achroia grisella* (source: Shimanuk and David 2000)



Plate 13 brood surface (open cells with immature pupae ) changed by wax moth (source: FAO 2006)

### 2.2.3. Ants

Ants are highly social insects which attacks the hive in mass, take and use different contents of the hive: dead or alive adult bees, the brood and honey. They are also nuisance for beekeepers and can bite them which is painful. Those colonies under ant attack become aggressive and difficult to manage and some times the colony will be abscond (Deslegn, 2001).

Both the traditional and modern hive can be attacked by ants. Some of the most common species of ants which attack bee colonies are the weaver ant (*Decophylla smaragdina*), the black ant (*Monomorium indicum* )and the fire ant (*solenopsis spp.*).The best way to control ants is to systematically search the ants' nests and when found destroy

them by burning and generally avoid nesting sites of ants by eliminating brush, rotten wood and cutting the grasses around apiaries ( Shimanuk and David, 2000).

#### **2.2.4. Spider**

Spiders usually form their webs at different sites of the hive for trapping flying adult bee workers, which results in the death of a number of worker bees making the colony weak so reduce in the production of honey and wax.

#### **2.2.5. Bee eater birds**

Birds hunt many insect species including honey bees. But the level of damaged caused by those birds varies based on the number of birds a single, few together or large flock descends upon few colonies of honey bees causes a decline in the population of worker honey bees in some or all the hives. Therefore the degree of damage is dependant on the number of the predator birds.

The most important means of protecting bee colonies from those predators is by carefully site selection and temporal relocation of the apiaries until the migration period is over.

### **2.3. Pests of honey bees common in Addis Ababa**

There are around 514 bee keepers in Addis Ababa city. There are diseases and pests which attack the bee colonies and reduce their products in the city. Adult honey bee diseases nosema and amoeba and the brood disease chalk brood and sac brood are the most common diseases in the city. Ants, wax moths, spider, small hive beetle and bee eater birds are also common honey bee pests and predators in most parts of Addis Ababa city (Yosef and Desalegn,).

### **3. Materials and Methods**

#### **3.1. Description of the study area**

The study was conducted in the capital city of Ethiopia, Addis Ababa. Addis Ababa is found at the centre of the country. The city hosts a number of continental and international organizations such as African Union (OAU), United Nations Economic Commission for Africa (ECA) and others. Due to the political, diplomatic and historical significance for the continent, Addis Ababa is often referred to as “the political capital of Africa”. The average annual temperature of Addis Ababa 15.9 degree calicoes and the altitude is 2,400 meters above sea level. The city is surrounded by sululta at the northern boarder, sebeta at the southern boarder, sendafa at the east boarder and burayo at the northern west boarder. The city is divided in to ten sub cities. These are Addis ketema located at the north western area of the city, Akaki Kality at the southernmost area, Arada at the northern area, Bole at the south ester area, Guela northern near the mountain Entoto, Kirkos at the center, Kolfa Keraniyo at the western part, Lideta at central western near the centre, Nifas Silk Lafto at the south western, Yeka at the north eastern part of the city. The study was made in all the ten sub cities of the city. In fact the bee keeping activity is more abundant in those sub cities which are away from the center. There for most bee colonies were selected from those sub cities which includes Nifas silk lafto, Kolfa keraniyo, Kaliti akaki, Gulela, Yeka and Bole.

### **3.2. Design of the survey**

The survey was conducted by using pre structured questioners, visual examination of the selected apiaries, field and laboratory diagnosis for the presence of pests. Pre structured questioner and interview were used to identify those pests which challenge their colonies. The bee keepers and their colonies were selected by purposive sampling method. Field and laboratory diagnosis for the pests (of the brood and adult) was also carried out to make the stud more reliable. Purposive sampling was utilized to include 100 bee keepers in the study. The researcher take in to account the following criteria; the willingness of the bee keepers, the location of the apiaries (whether are easily accessible for transportation because the samples were collected at night) and the number of bee colonies owned by the bee keepers.

536 bee colonies (hives) owned by those 100 bee keepers were used for the study. Most bee colonies were selected from the sub cities which are away from the center as they host a number of beekeepers than those sub cities found at the center. Pre structured questioners were used for the interview with the 100 bee keepers. And to make the study more reliable field diagnosis for the clinical signs of brood diseases and laboratory<sup>2</sup> diagnosis was conducted for the adult and brood diseases and parasites. The field diagnosis and the laboratory diagnosis was based on the willingness of the bee keepers, there for out of 536 bee colonies 200 bee colonies were used for the field diagnosis of the brood diseases. And 50 dead adult bee samples each sample consisting of > 200 bees from 50 bee colonies owned by different bee keepers and 20 brood samples combs, each comb having an area of 25cm X 25cm was collected for laboratory diagnosis.

### **3.3. Sampling technique**

Purposive sampling was utilized to include 100 beekeepers for the study. This sampling method was perfect because the researcher must take into account whether the owners are volunteer, the aperies are accessible for transportation and safe because the samples were collected at night and emphasis was also given to those with large number of colonies. For the field diagnosis 200 brood colonies were selected from those bee keepers who were volunteer and for the diagnosis and for the laboratory diagnosis since this diagnosis requires taking samples of the adult and brood most of the bee keepers were not volunteer only 50 bee keepers allow the researcher to take samples of adult honey bees there for 50 dead adult bee samples were collected each sample with >200 bees and only 20 beekeepers allow to take brood samples there for only 20 brood samples were collected each sample having an area of 25cm X 25cm.

### **3.4. Methods of data collection and tools**

Questionnaires were used to collect data from the 100 bee keepers about the major pests and predators which challenge their colonies. 536 hives were visually examined for the presence of pests, predators and for about 200 hives field diagnosis have been conducted for the clinical signs of the brood diseases AFB, EFB,SB and CB. Searching for the clinical signs for AFB such as color change in the brood cell, larvae or pupa, brittle scale adhere tightly to the cell and match stick test (inserting match stick into the brood and with draw ropy material to about 2.5cm). for EFB searching for odor, perforated or sunken capping and black scale. Looking for uncapped infected or dead larvae and chalk white mummies at the entrance of the hive floor for the disease CB. The researcher also search for the sign of SB such as pearly white to gray or black colored larvae, dead larvae prior to pupation and retarded development of head. Every data obtained from the questionnaires and from the field diagnosis was properly recorded. Finally bee colonies

samples were collected for laboratory diagnosis by using sampling bottles, gloves, paper bags and plastic bags. 50 beekeepers were volunteer out of the 100 beekeepers, from the ten sub cities and 50 bee colonies were isolated and 50 samples were collected, containing > 200 adult honey bees were collected by using a leak proof sampling container and killed by immersing in 70% ethyl alcohol and Each container was labeled; sample type, sub city, woreda, date of collection and collector's name. Until morning, because the samples were collected at night, the samples were placed in a cool and dry place. 20 brood samples were collected from 20 different bee colonies owned by different bee keepers. First the brood for the sample was chosen based on its color, appearance and capping of the brood cells. 25cm × 25cm area of the brood was carefully removed from the hive by using a small knife and was loosely wrapped in a paper bag and covered by a plastic bag and was placed in a refrigerator until morning during when the laboratory diagnosis will take place. The data from the field diagnosis was collected by looking at the clinical signs for the brood diseases AFB, EFB, CB and SB, also the laboratory diagnosis was also conducted for the adult bee disease nosema and amoeba, 20--30 dead adult bees were taken from each sample, then the abdominal part was cut using scissors and grinded in 2ml of distilled water. Microscopic examination was conducted under 40X magnification power of a microscope for nosema spores and for amoeba cysts. For the parasite varroa the laboratory diagnosis was also conducted for both the adult honey bee and brood. For the adult honey bee the dead bees in a bottle of 70% alcohol consisting of >200 bees were shaken for one minute (which is effective for dislodging 90% of the varroa). The mites were collected by passing the bees and alcohol through a cotton cloth and the mites were examined and counted from the cotton clothe (plate 14). For the parasite varroa 20 brood samples were collected, the samples had an area about 25cm X 25cm carefully removed from the hive using knife and immediately warped by a paper bag and covered by a plastic bag. Then is placed in a refrigerator, because the

collection was done at night. In the morning the diagnosis was conducted by opening every brood cell searching for the parasite visually and counting the number of parasites present and the number of the broods in the sample.



Plate 14 mites isolated from adult honey bees in the laboratory (Holeta Bee Research Center 2017)

### **3.5. Statistical analysis**

Statistical tables and graphs are used to show the distribution and frequency of the honey bee diseases and pests at each sub city of Addis Ababa.

## **4. Result**

### **4.1. Overall pest prevalence in Addis Ababa**

In Addis Ababa the most common pests and predators for the honey bee colonies are ants, wax moth, spider and bee eater birds. Out of 536 bee colonies examined for the pests and predators 165 (30.8%) of the colonies were attacked by ants, 73 (13.6%) by spider, 54 (10.0%) by wax moth and 77 (14.3%) was by the bee eater birds. The maximum prevalence rate of ant attack was recorded 34 (42.5%) in bole sub city. The highest prevalence rate of 22 (27.5%) of spider attack was also recorded in Bole sub city. The maximum prevalence rate of wax moth attack was recorded in arada sub city which is 9 (32.1%). In akaki kaity sub city the attack by the bee eater birds was the maximum 15 (24.6%). ( table 2) ( plates 15-25)

Table 2. the most common pests and predators that attack bee colonies and their prevalence rate in the ten sub cities of Addis Ababa

Sub city	Number of colonies examined	Frequency of colonies attacked							
		ants		Spider		Wax moth		Bee eater birds	
		No	%	No	%	No	%	No	%
N/S/L	76	24	31.6	2	2.6	5	6.6	6	7.9
Yeka	85	25	29.8	4	4.7	7	8.2	14	16.5
Gulela	43	16	37.2	9	20.8	8	18.6	8	18.6
Kolfa Keraniyo	128	37	28.9	17	13.3	8	6.2	7	5.4
Akaki Kality	61	21	34.4	12	19.6	6	9.8	15	24.6
Bole	80	34	42.5	22	27.5	9	11.2	17	21.2
Kirkos	14	2	14.3	2	14.3	---	0	3	21.4
Lideta	9	1	11.1	1	11.1	1	11.1	---	0
Arada	28	3	10.7	2	7.1	9	32.1	5	17.8
Addis Ketema	12	2	16.7	2	16.6	1	8.3	2	16.6
total	536	165	30.8	73	13.6	54	10.0	77	14.3

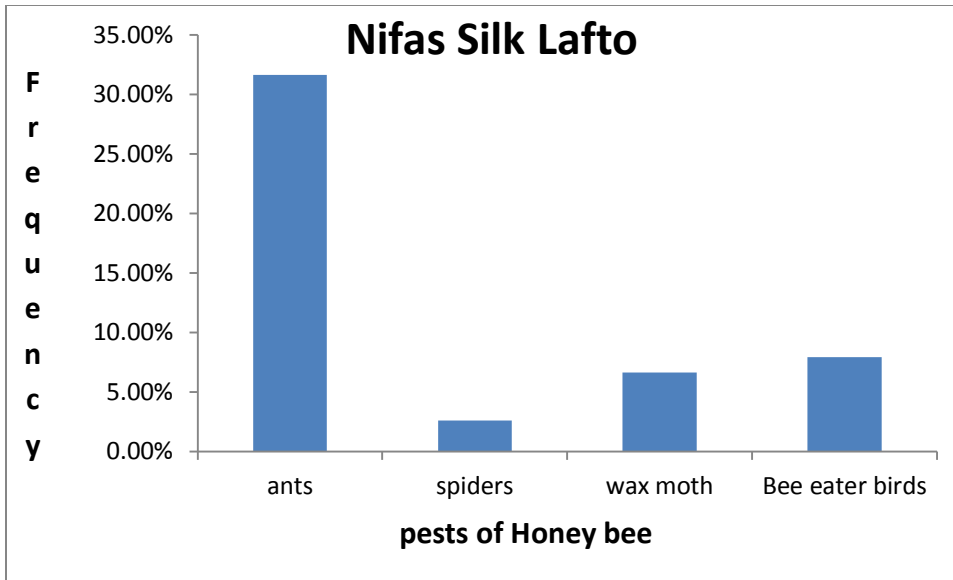


Plate 15. distribution of pests in Nifas silk lafto sub city

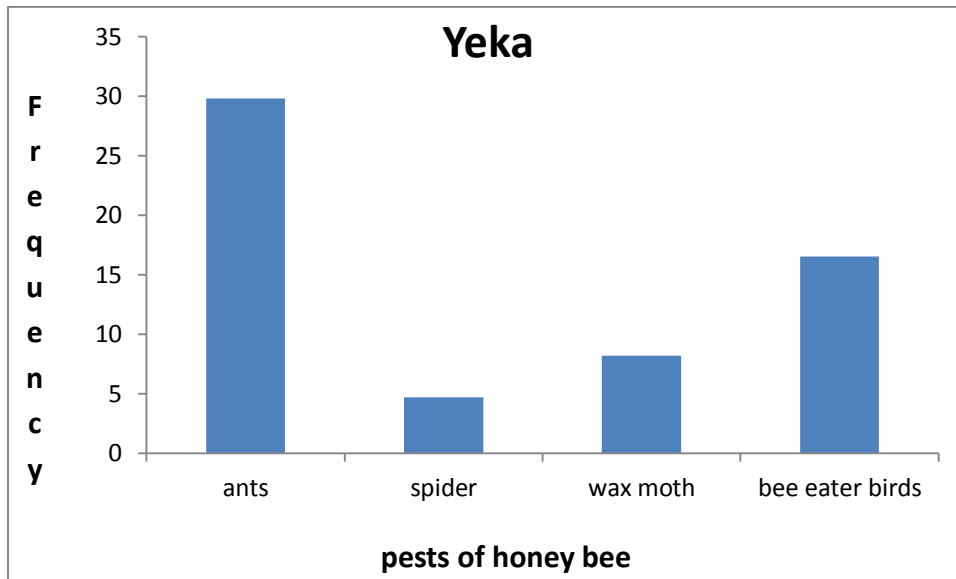


Plate 16. Distribution of pests in Yeka sub city

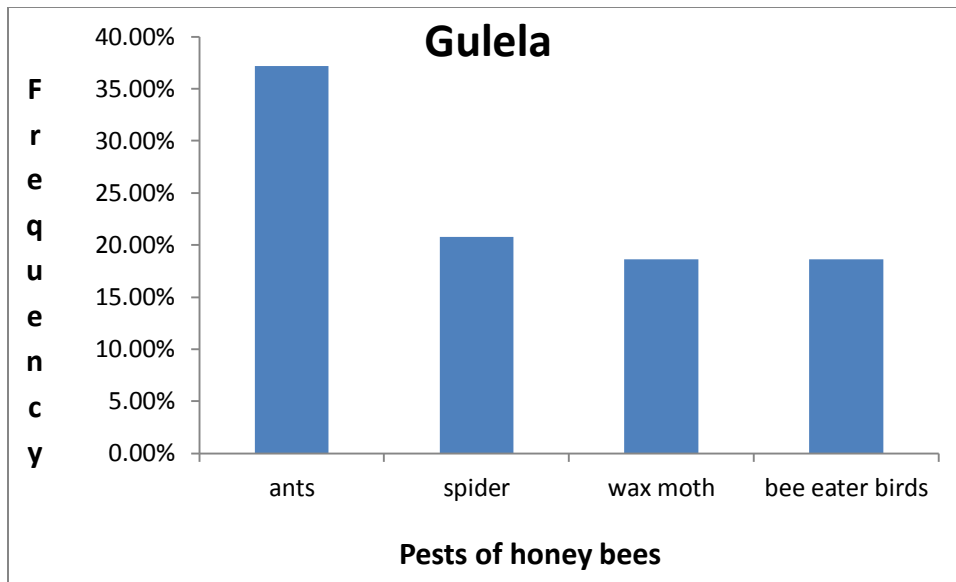


Plate 17 . Distribution of pests and predators in Gulela sub city

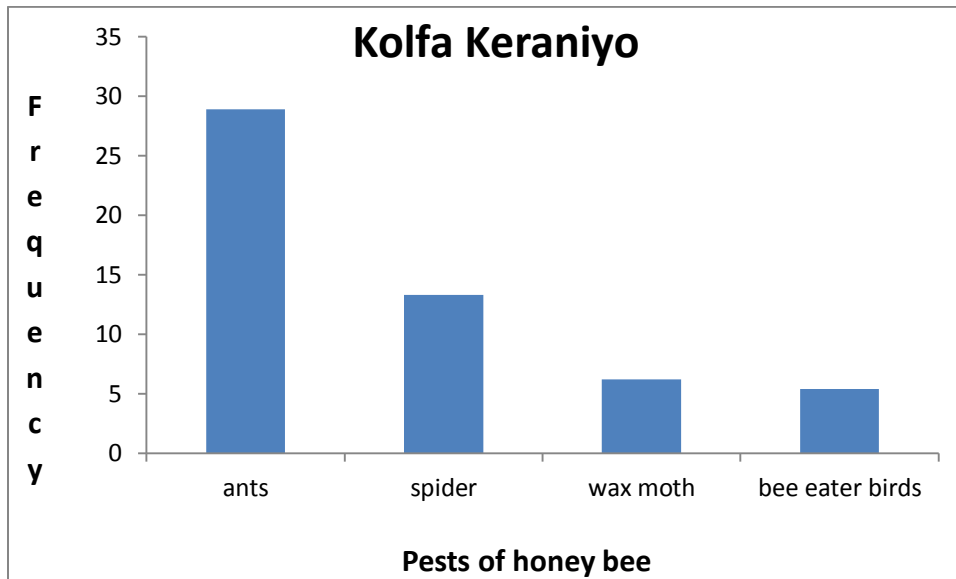


Plate 18. Distribution of pests and predators in kolfe sub city

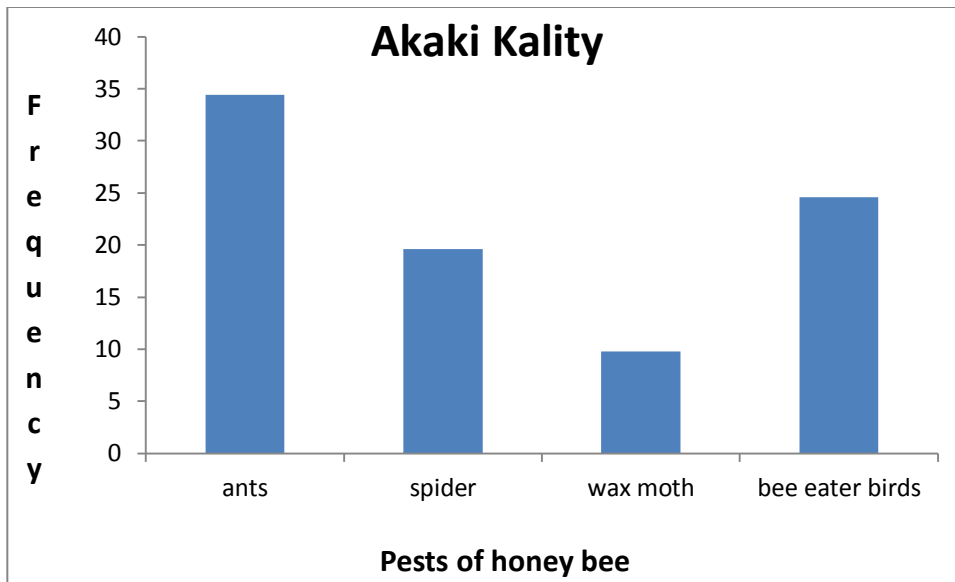


Plate 19. Distribution of pests and predators in Akaki kality sub city

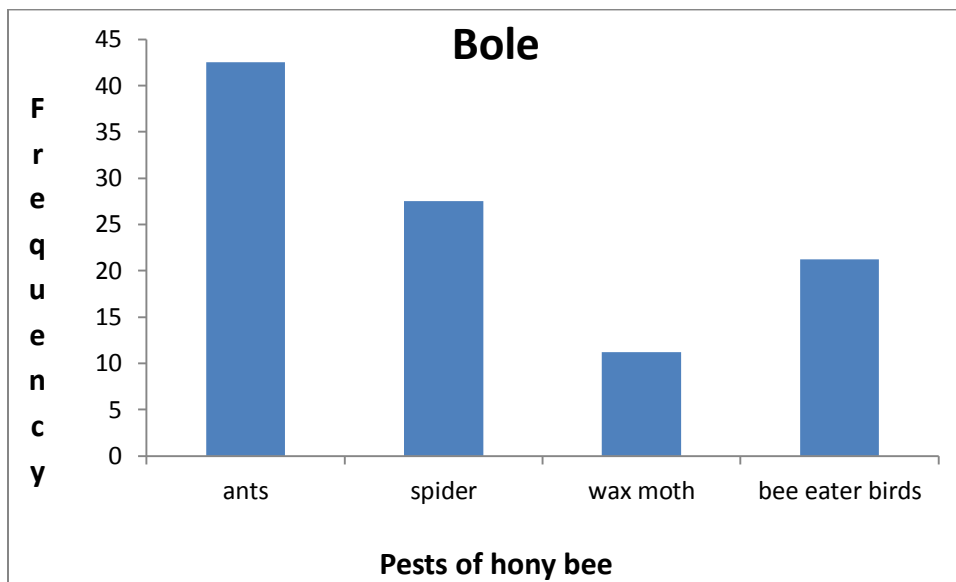


Plate 20. Distribution of pests and predators in Bole sub city

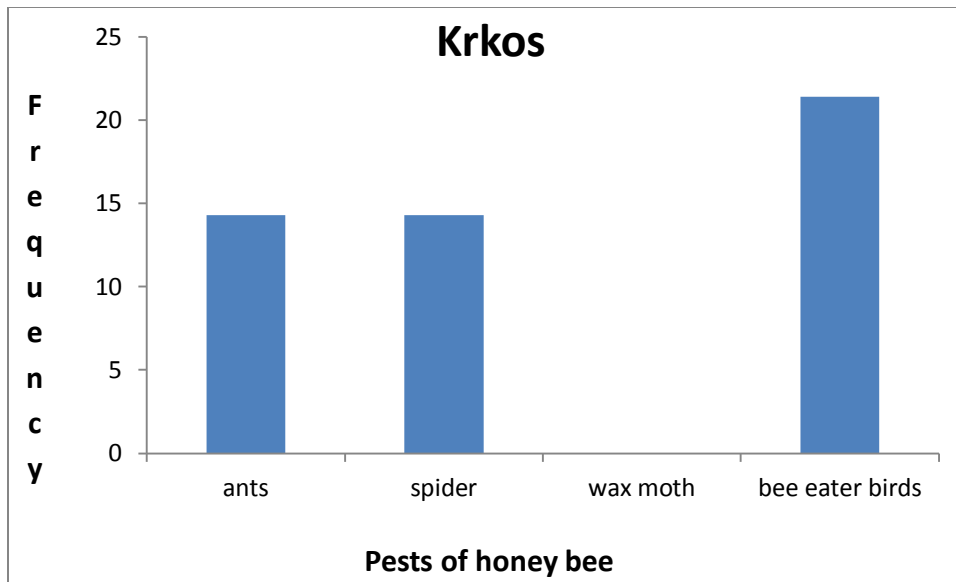


Plate 21. Distribution of pests and predators in Kirkos sub city

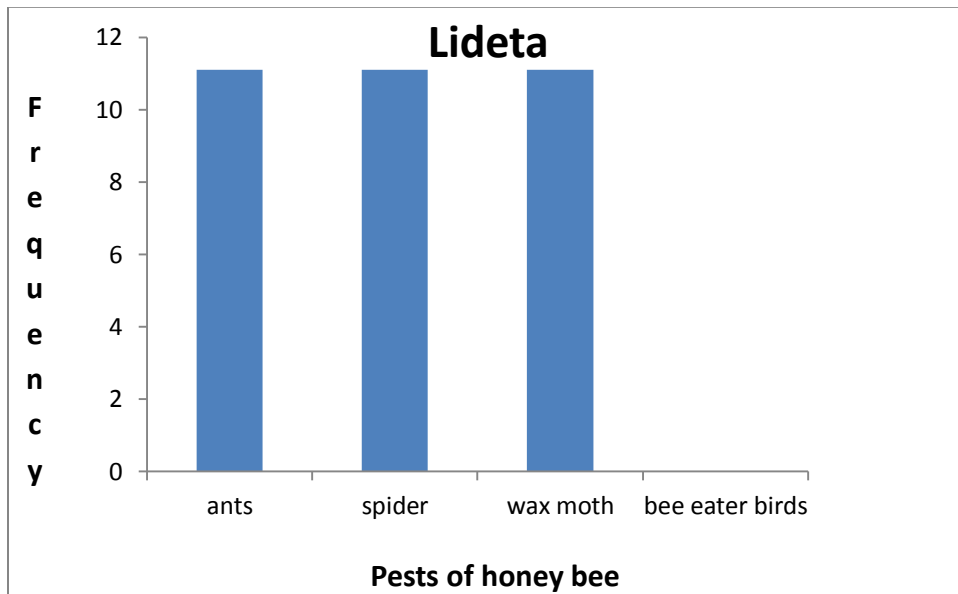


Plate 22. Distribution of pests and predators in Lideta sub city

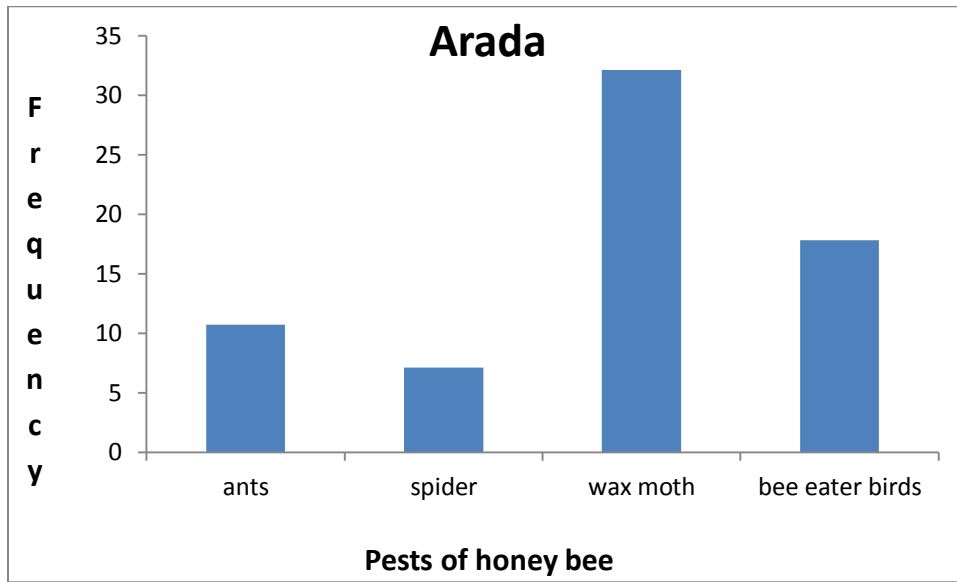


Plate 23. Distribution of pests and predators in Arada sub city

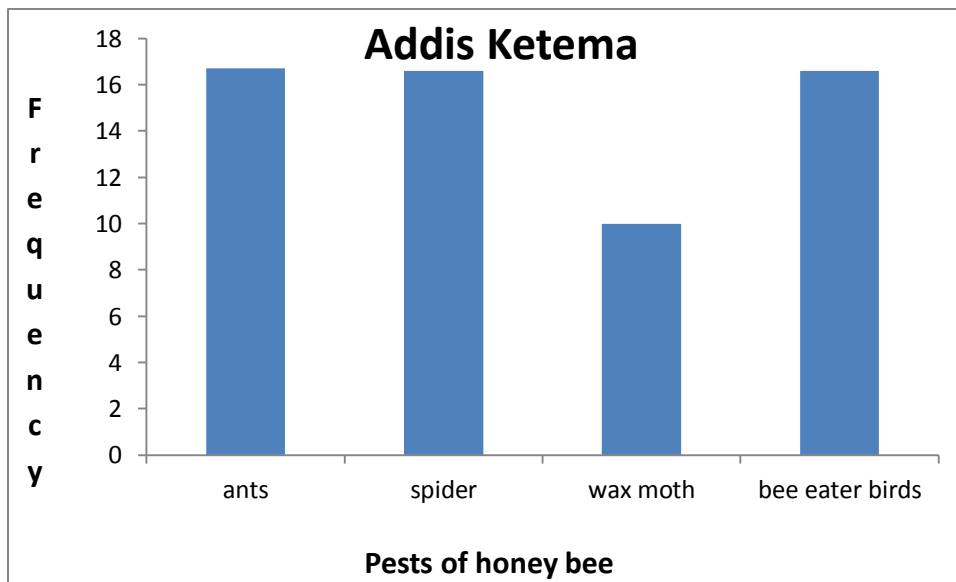


Plate 24. Distribution of pests Addis ketema sub city

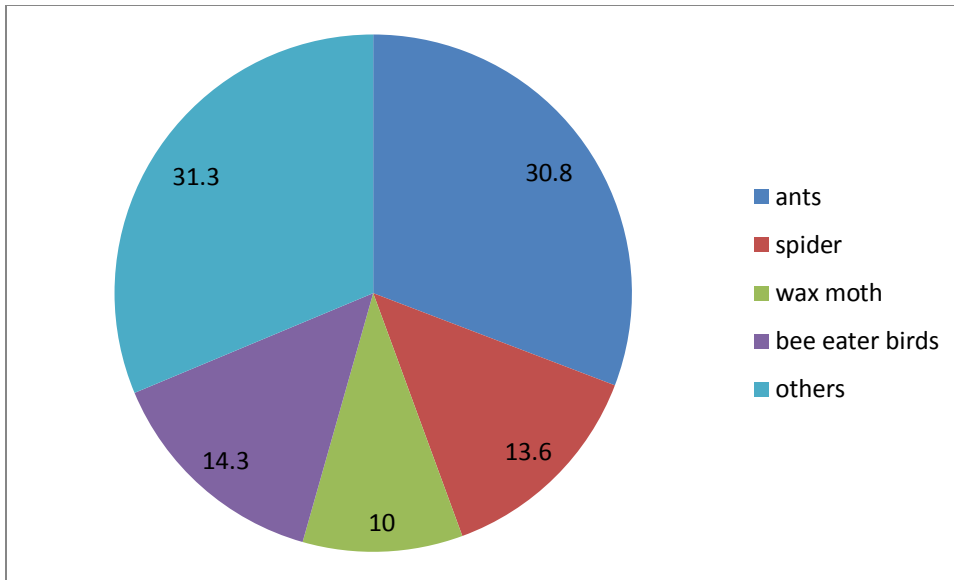


Plate 25. Distribution of pests and predators in Addis Ababa

## 4.2. Over all disease and parasite prevalence of honey bees in Addis Ababa

### 4.2.1. Disease and parasite prevalence of the adult honey bee in Addis Ababa.

The diseases nosema and amoeba were detected in all the samples collected from the ten sub cities of the city and the prevalence rate was 100%. ( plate 26) ( table 3)

The parasite *varroa* was also detected in all the samples taken from the ten sub cities. From 10,406 bees in the 50 samples 95 (9.1%) varroa parasites were detected. Yeka sub city with 15 (1.1%) varroa had the maximum prevalence rate. In fact the distribution of the parasite in most sub cities is similar with a slight difference. ( table 4)

Table 3. prevalence of the adult bee colonies for the disease amoeba and nosema.

Sub city	Number of samples	Result of the diagnosis for amoeba and nosema
N/S/L	7	All Positive infestation
Yeka	8	All Positive infestation
Gulela	8	All Positive infestation
Kolfa Keraniyo	7	All Positive infestation
Akaki Kality	7	All Positive infestation
Bole	8	All Positive infestation
Kirkos	2	All Positive infestation
Lideta	1	All Positive infestation
Arada	1	All Positive infestation
Addis Ketema	1	All Positive infestation
Total	50	100%

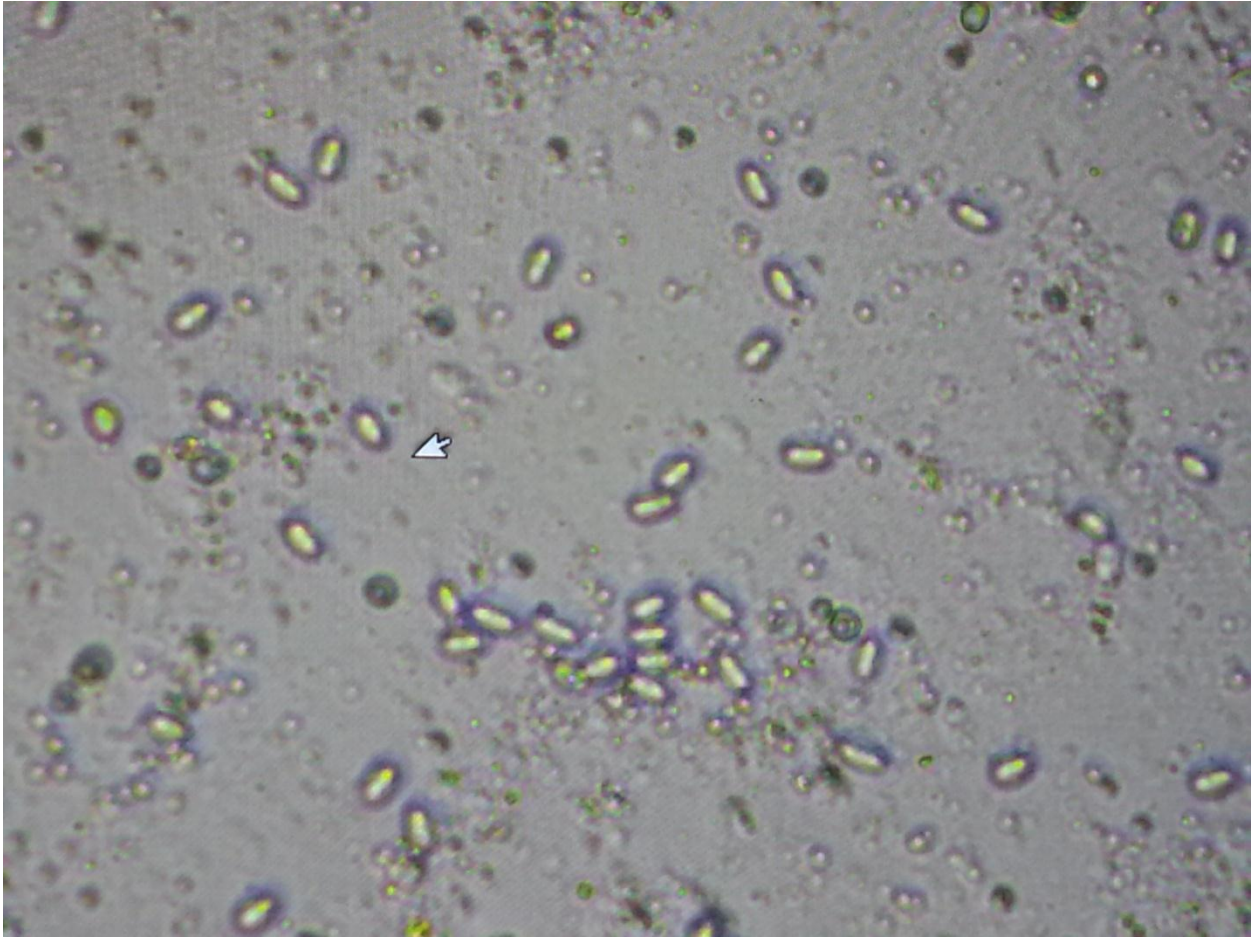


plate 26. nosema spores (Holeta Bee Research Center 2017 from the collected data)

Table 4. Prevalence of the adult bee colony for the parasite *varroa*

Sub city	Number adult bees	Frequency of collected <i>varroa</i> from the samples	
N/S/L	1,937	21	1.1%
Yeka	990	15	1.5%
Gulela	1,400	13	0.9%
Kolfa Keraniyo	1,655	18	1.1%
Akaki Kality	1,960	27	1.3%
Bole	1,015	13	1.2%
Kirkos	516	3	0.5%
Lideta	240	1	0.4%
Arada	369	2	0.5%
Addis Ketema	324	2	0.6%
Total	10,406	95	9.1

#### 4.2.2. Disease and parasite prevalence of the brood in Addis Ababa

According to the result obtained from the field diagnosis all the examined broods were free from any of the brood diseases; EFB, AFB, CB, and SB.( table 5)

Table 5. Prevalence of bee colonies for the brood diseases American foul brood, European foul brood, sac brood and chalk brood.

Sub city	Number of colonies examined	Number of colonies with AFB	Number of colonies with EFB	Number of colonies with SB	Number of colonies with CB
N/S/L	30	0	0	0	0
Yeka	35	0	0	0	0
Gulela	15	0	0	0	0
Kolfa Keraniyo	40	0	0	0	0
Akaki Kality	20	0	0	0	0
Bole	30	0	0	0	0
Kirkos	6	0	0	0	0
Lideta	4	0	0	0	0
Arada	12	0	0	0	0
Addis Ketema	8	0	0	0	0
Total	200	0	0	0	0

Based on the result obtained from the laboratory diagnosis the parasite varroa was found in most sub cities. (plate 27)

From the 20 samples 1218 broods were counted and 156 varroa were isolated, most of the varroa was isolated from the drone broods which were collected from nifas silk lafto sub city where the maximum prevalence rate was recorded.( table 6)

Table 6. Prevalence of the brood for the parasite *varroa*

Sub city	Number of brood samples	Number of individual broods	Number of <i>varroa</i>	
N/S/L	3	162	76(most drone broods)	46.9%
Yeka	3	200	16	8%
Gulela	2	104	5	4.8%
Kolfa Keraniyo	4	320	47	14.6%
Akaki Kality	2	105	3	2.8%
Bole	3	158	6	3.7%
Kirkos	1	50		0%
Lideta	--	--	--	---
Arada	1	61	1	1.6%
Addis Ketema	1	78	2	2.5%



Plate 27. Mites on the brood of the collected sample (Holeta Bee Research Center 2017)

## **5. Discussion**

The occurrence and distribution of honey bee diseases, pests and predators in Addis Ababa is not fully understood by all the bee keepers. Especially all the bee keepers in the study have no any clues about honey bee diseases but have little information about some honey bee pests and predators and some bee keepers have also developed traditional way of controlling pests and predators. The result of this diagnosis survey shown that there are pests, predators, parasites and diseases of honey bee that attack the adult bee colony or/and the brood exists in the city similar result with the result obtained by (Desalegn, and Yosef , 2005). It is also noticed that they cause an enormous damage on the bee colonies (adult and brood) and their products. Among the most frequent pests and predators, ants are the major ones. Even if the bee keepers use traditional means to control ants like using used engine oil and ash at the base of their hives, ants are causing damage in the bee products (honey) and also causes absconding of the colony, which results in the total loss of colonies. This has been a challenge for the sector for many years and still have no scientific solution provided for the bee keepers from any governmental or nongovernmental concerned organizations. Because ones the ants start to appear at that area they may disappear for the time by the traditional control but they reappear again and again until they get the chance to attack the colony, that's why ants are the most important pests of the bee keeping sector. Although it is very easy to remove spiders and spider webs from and around the hive, spiders are causing damage in the bee keeping sector. As shown in the study those hives which had no regular supervision, the spiders form webs at the entrance and at different sites of the hive and trap worker bees which consequently reduces the number of bees in the colony which finally reduce their products and weakens the colony making the colony susceptible to other pests, predators and pathogens similar with the result obtain by Desalegn and Yosef, 2005 .

Wax moth are the other pests which challenge the bee keeping sector in the city, the wax moths usually attack bee colonies when the colony gets weak, a colony may get weak due to starvation, disease or other reasons, during this time the wax moth's larvae start to grow inside the brood comb and this causes damage in the brood and honey combs if the colony fails to control this can cause great damage and finally can lead to absconding of the colony. The bee keepers in the city have also traditional means to control and reduce the destruction caused by the wax moth, using smoke produced by burning different plants which is not that much effective. Although seasonal, the bee eater birds also cause a huge damage. Those birds usually immigrate to the city starting from the month march and can stay for three or four months causing destruction in the sector. Amoeba and nosema were becoming the most common infections of adult honey bees in the city, as they are common in most parts of the country as mentioned by Amsalu, and Desalegn. in 2005. The spores of nosema and the cysts of amoeba were detected in all the samples taken from the whole parts of the city, although the degree of infestation varies in different parts of the city. Even though the frequency of the parasite *varroa* was not pronounced, it is true that, the parasite was detected in both the brood and adult honey bee samples in all the sub cities of the city. As mentioned by Shimanuki and David in 2000 especially the brood samples which are drones contain amazingly large numbers of *varroa* from any other brood or even the adult, this indicates that the parasite prefers drone broods to other broods or adults.

The field diagnosis indicated that the honey bee colonies in the survey areas are apparently free from AFB, EFB, CB and SB, which are very serious diseases of broods, which cause great destruction in other bee keeping countries. This result contradicts with the result obtained by Desalegn and Yosef in 2005 because their result indicates the presence of the brood diseases SB and CB.

In addition to what have been described in this study, there are also small hive beetle which cause destruction to the bee colonies.

All the bee keepers in the study agree that the bee keeping sector is the most profitable, non tiredious and not time consuming sector than any other agricultural sector but it needs close supervision to identify early if there is any occurrence of pests, predators and disease in the aparis .

During the study it was identified that the city have no problem of forage and water throughout the year (which is a problem in other parts of the country) because there are ornamental plants across the roads, in compounds and everywhere in the city. That is why most bee keepers call Addis as city of honey. At the beginning of the study around 220 beekeepers were asked to participate in the study, but most of them refused due to several reasons. Even those who were volunteer for the interview and field diagnosis, didn't allow to open their hives and to take samples for the laboratory diagnosis due to their traditional belief , some believes that there will be reduction in the number of colony, some believes that absconding will be caused and reduction of honey and wax products will be reduced and other reasons. For the future it is advisable for other researchers to make the beekeepers aware about the study and to explain the benefits which the beekeeper will obtain from the outcome of the study. This will enable the researchers to take as many as possible samples and identify diseases, pests, parasites and predators which attack the bee colonies.

## 6. Conclusions and recommendation

### 6.1. Conclusions

According to the result obtained from the survey the most serious challenges of the bee keeping sector in Addis Ababa are the pests and predators (ant, wax moth, spider and bee eater birds) and the adult diseases nosema and amoeba also the parasite *varroa* which attack both the adult and the brood. Even though the brood colonies are free from AFB, EFB, CB and SB there are parasites which cause damage in the colony especially the drone brood is highly affected by the *varroa* parasite.

### 6.2. Recommendation

- It is always better and easier to protect colonies of bee from any damage caused by pests, predators, parasites and pathogens, than cure after been exposed to those factors. Although the bee colonies are free from the most serious brood diseases like AFB, EFB, SB and CB, it is important that the bee keepers be able to recognize any abnormality in their bee colonies, even if are less serious diseases, so as not to confuse them with the serious ones. If so, it will be possible to control even the most serious diseases, before great destruction of the sector takes place. In addition, it is advisable to avoid giving table honey or any foreign honey from unknown sources for their bee colonies.
- Moreover, good sanitation, regular inspection of the food and the water the bee colonies use are also very important. It is advisable to provide a suitable water sources close to the hive. In the case of the serious brood diseases such as chalk brood and others, it is preferable to cut and burn the affected brood comb and strengthening the colonies.

- Bee keepers must keep in consideration to have enough information about the bee equipments when buying used bee equipments from abroad
- The economically important brood diseases; the AFB and EFB diseases non existence presently in the country does not guarantee for tomorrow unless Ethiopia must have rules and regulations on factors which endanger the honey bee colonies of the country.
- Besides the regulations there should always be strong quarantine on imported used bee equipments to avoid the introduction of serious honey bee diseases and also is advisable disinfecting used equipments before use.
- Controlling the common honey bee pests by cultural methods and modern ways is also important to protect the bee colonies. For example, for ants, by making the apiaries free from debris which attract ants, using used engine oil and ash at the base of the hive and others.

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