Original Research Article

Relative abundance and status of honey bee pests and diseases in Ari district of south western Ethiopia

ABSTRACT

Aims: To determine the species composition, relative abundance and status of honey bee pests and diseases in Ari district of Inka zone of southern western Ethiopia.
Study design: Four major honey producing peasant associations (PAs) representing diverse ecological zones were selected purposively, while the sub-localities, villages and beekeepers were selected randomly using a nested design
Place and Duration of Study: Survey was conducted between 1, august 2019 and 30, January 2020 with the interval of one month in major honey producing peasant associations representing diverse ecological zones of Ari district of south western Ethiopia..
Methodology: The assessment on abundance and status was made from of half kilogram of fresh and dry honey comb samples were taken from 720 farmer's hives of four peasant associations using key of books related to stored product insects.
Results: Five species of predators and parasitoids belonging to four orders were recorded. Of these 76.63% accounts for small hive beetles, followed 38.31%) and wasps (19.92%). Besides, six type's diseases of honey bee caused by different pathogens were recorded. Of which, Chalk brood, other virosis, European foulbrood and American foulbrood, respectively were the most frequently occurring. In terms of the status, the diseases of honey bee were in the following orders, i.e., Chalk brood > other virosis, > European foulbrood > American foulbrood > American foulbrood > Sac Brood Virus, while their pests were in the following orders, i.e., Small hive beetles > Ants > Wasps > Wax moths > Spiders.
Conclusion: Arthropod pests and diseases were the most important constraints of honey colony and honey production in the study areas. Thus, it is important to design and implement effective management strategies to reduce loss of honey colony and honey production in the study area.

Keywords: Honey bee, pests, diseases, beekeeping, status, hives, abundence

1. INTRODUCTION

Beekeeping is an appropriate and well accepted farming technology that has been suited to extensive range of tropical Africa. It is important in diverse way including in production of honey, bee wax, queen, bee colonies and other products such as pollen, royal jelly, bee venom and propolis in cosmetics and medicines. Additional role of beekeeping is pollination of food crops and many plant species used for conservation of the natural environment and can be integrated the other activities like crop production, animal husbandry and horticulture crops [1, 2]. Apiculture is a deep rooted and long standing activity in Ethiopia where honey bee colonies are kept in traditional hives in backyard and in forest using different management practices. It accounts 1.3% of agricultural GDP and currently one out of ten rural households is being engaged in it and its contribution is substantial to rural income generation [3, 4].

However, beekeeping and honeybee colony establishment has been declining extremely in contemporary beekeeping in Ethiopia as a result different abiotic and biotic factors. Among biotic constraints, pests and diseases are reported to be fundamental factors that are responsible significant decline of honey bee colony and beekeeping [5].

Consequently, there is a need for undertaking extensive research in such area (pests and diseases of honey bee) that affect honeybee health [6, 7]. Hence, conducting consistent (routine) surveillances and monitoring as well as research regarding the diseases and pests honey bee and attempting to fill this gap accordingly is the key steps to protect honeybee colonies, honey production and beekeeping from harmful diseases and pests [8]. Besides, survey and research

on pests and disease of honey bee might also provide baseline information that could help designing their effective preventive and management strategies that could easily adopted by beekeepers. Furthermore, though some research works associated honey bee colony health (pests and diseases of honey bee) was conducted in different parts of the country, there is still lack of relevant and documented information regarding the relative abundance, species composition and the status of honey bee pests and diseases in the study area, in particular and Ethiopia, in general.

Therefore, to at least address some of the aforementioned gaps the current survey is designed with the objective of determining the species composition, relative abundance and status of honey bee pests and diseases in Ari district of Inka zone of south western Ethiopia.

2. MATERIAL AND METHODS

2.1 The Study Area Descriptions

The study was conducted in South Ari Woreda or district of South Omo Zone of Southwest Ethiopia. The woreda is located 678 km away from Addis Ababa (the capital city of Ethiopia), and its area is 1521 km2, 547 km away from Hawassa (the capital city of SNNPR state), 17 km away from Jinka (the capital city of South Omo Zone). The woreda is sub-divided in to 46 kebeles and four urban centers, Gazer (the capital city of Ari woreda), Metser, Tolta and Wubhamer. South Ari is bordered on the south by Benatsemy, on the west by Mago river, on the north by Basketo (special woreda), on the northeast by Gamogofa zone and on the east by Male. The highest point in the woreda is Mount Ager (3418 meters above sea level, i.e. asl) and mount Pilpa (3217 meters asl) (Figure 1). The study was conducted from 1, August to 30, November, 2019.

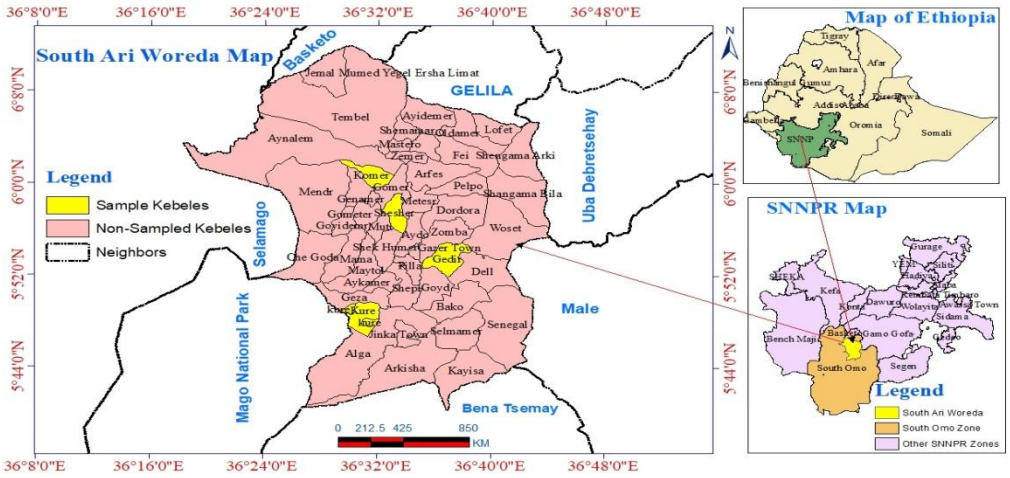

Figure 1 Map of the study site

3.2 The Study Design and Sampling Procedure

2.2.1 The Study Design

Out of 46 kebeles in the district, four (4) kebeles or peasant associations (PAs) representing diverse ecological zones (Kure, Komer, Gedir and Sheshir) were selected purposively with the assistance of the Ministry of Agriculture (MOA) sub-kebele staff, while the sub-localities, villages and beekeepers were selected randomly using a nested design as adopted by earlier researchers [9, 10].

2.2.2 Sampling Procedure

From each peasant associations (PAs), about three sub-localities were randomly selected and from each sub-locality, three villages were selected at random with the assistance of the Ministry of Agriculture (MOA) sub-kebele staff as adopted by earlier researchers ([9, 10]. Kebeles were selected purposefully based on abundance of honey production, such that those kebeles growing honey largely were selected for the survey, while villages, representative farmers and their hives were selected randomly.

2.3 Determination of the Species Composition, Relative Abundance and Status of Insect Pests

Out of 36 randomly selected villages in the aforementioned manner, a total of 720 farmers apiaries were selected randomly (two from each village) and 0.5 kg of fresh and dry honey comb samples were taken and the presence of pests and diseases in apiaries were tested, identified as well as their pictures were taken. In the selected apiaries, inspection of honeybee colonies and sampling of randomly picked life worker bees and bee brood (egg, larva and pupa both live and decayed) were also carried out for identification diseases and pests of honey bee under laboratory conditions using morphometric as indicted by earlier scientists [11, 12, 3, 14, 15]. Samples of pests and parasites that were found in or around hives were collected for laboratory conformation. Samples were taken by brushing the bees off the comb through large mounted funnel or directly in universal bottle and killed and preserved in 70% methyl alcohol and labeled accordingly.

Each sample at each sampling date from each farmer's apiaries at each villages of the sampling site was collected in sampling bag or jar, labeled with necessary information and kept for further identification of insect pests and diseases. The samples of pests, workers and honey combs were brought to Zoology laboratory Jinka University for identification. The brood examination was conducted by random opening of brood cells. The brood was removed from the cell with a fine forceps and the cells were inspected for the presence of pests.

The samples from different farmers' apiaries of villages of the same peasant association were sub sampled further after thoroughly mixing them to come up with a standard of 10 g (0.1kg) sample. Then, the procedures and keys of the books related with honey bee insect pests and diseases by different scientists (Shimanuki et al 1990; Shimanuki and Knox 1991; Ritter and Akratanakul, 2006; Sammataro and Yoder; 2011; FAO, 2018) were used for identification purpose. Besides, keys and pictures from on line available literatures were also used for identification. Then after, insect pests and diseases were sorted according to their orders, families and species, and counted for each subsample honey from each of different farmer's traditional apiaries from each village, in each case noting the number.

Then after, the species composition, abundance and status of pests and diseases were determined using the formulas indicated below. The average of the sum total of species of arthropods (insect pests) and diseases collected from sub-samples was used to determine the species composition, abundance and status of pests and diseases. For assessing pest's infestations, the main variables have been included abundance, relative abundance and Constance (frequency) of species found in samples as suggested by earlier researcher [16]. Abundance refers to the total number individuals of a species divided by the total number of samples (in this case the total number of kilograms) and it is expressed by the following formula:

$$\text{Abundance of species} = \frac{\text{Total number of individuals of species}}{\text{Total number of samples}}$$

The relative abundance of species is expressed by the percentage of individuals of the species in a total number of observed individuals as shown in the following formula:

$$\text{Relative Abundance of species} = \frac{\text{Number of individuals of a species}}{\text{Total number of observed individuals}} \times 100$$

Constance (frequency) expresses the percentage of species occurrence. It is obtained by the relationship between the number of samples containing the species and the total number of samples. The following formula is expressing this relationship.

$$\text{Constance of species} = \frac{\text{Number of samples in which the species occurred}}{\text{Total number of sample}} \times 100$$

2.4 Data management and analysis

All the data that were collected from survey were managed and analyzed using Microsoft Excel version 2013 and Statistical Program for Social Sciences (SPSS) version 16. Descriptive statistics (mean and percentage) were used for compiling and computing data collected on relative abundance, species composition and the status of honey bee pests and disease. Significant differences between means were separated by Tukey's honestly significant difference (THSD) test at 95% confidence interval level.

3. RESULTS AND DISCUSSION

3.1 The Relative Abundance, Species Composition and the Status of Honeybee Pests in Ari District

Table 1 and 2 demonstrated different categories of insect pests (predators or parasitoids) honey bee that were recorded from honey bee samples collected from different apiaries of Ari district.

Accordingly, five species of natural enemies (predators and parasitoids) belonging to four orders with in five family were recorded. Of these 76.63% accounts for small hive beetles from order Coleopteran with in the family Nitidulidae, followed by ants (38.31%) and wasps (19.92%) from order Hymenoptera with in two families Formicidae and Vespidae, respectively. However, the remaining 11.87 % and 8.81% were the greater wax moths and spiders of family Pyralidae and Theridiida of orders Lepidoptera and Araneae, respectively. Similarly, pervious researcher [17] reported that as different insect pests from different orders such as Coleopteran (including Aethina tumida of family Nitidulidae), Lepidoptera (including *Galleria mellonella* and *Achroea grisella* of family Pyralidae) and Hymenoptera (including *Dorylus* spp of family of Formicidae and *Vespa* species of family Vespidae) seriously affects honey bee colony and honey production.

Of the aforementioned five species of predators and parasitoids of honey bee recorded, small hive beetles, followed by ants were the most abundant as they account for about 27.78 and 13.89 mean numbers of individuals, respectively per 10 g of honey sample. They were also the most frequently occurring as they occurred in 94.44% and 83.33%, respectively per 10 g of honey sample. Following these species, wasps and wax moths, respectively were the next abundant and frequently prevalent. However, spiders were the least abundant and less frequently occurring (Tables 1 and 2).

Generally, in terms of abundance, relative abundance, frequency of occurrence and status (economic importance), the pests of honey be recorded from honey samples collected from Ari district were found to be in the following orders, i.e., Small hive beetles > Ants > Wasps > Wax moths > Spiders (Table 1). These natural enemies cause significant loss in apiculture by destroying combs, stores, hive and taking foraging of worker as they leave hive and by being true parasitoids by raising their offspring in bodies of bees [17]. The various pests honey bee recorded from Ari district in the current study is in agreement with the report of [18], in which ants, beetle, moths, lice, termites, mites, and large vertebrate animals such as amphibians, reptile, lizards, birds, mammals like honey badgers and mice were recognized as pests of honey bees in Ethiopia. In accordance to various arthropod pests in the current study area earlier scientist [8] also reported that as different types ants, wax moth (greater and lesser wax moths), mice, birds (different types), honey badger, wasps, death's head hawks moth, bee lice (*braula coeca*), beetles (different types), lizards, toads/frog, prey-mantis, spiders, *pseudo scorpions* (chelifer species) were registered as the major honeybee pests locally in Ethiopia. Similarly, previous researcher [19] also reported as different types honey pests such as honey badger, spider, bee-eating birds, bee lice, beetles, wasps, Death Head hawks, moth mice and lizards were recognized in Bale zone of southeastern Ethiopia.

Furthermore, the categorization and determination of their economic status (importance) in the present study is in agreement with the works or reports of previous scientists [11, 12, 3, 14, 15], in which all the identified species honey be pests were indicated as they significantly affect honey bee colony and honey production in different part of the world either indirectly by causing loss of honey (feed of the brood) or directly being parasitoid or predators of honey bee.

Moreover, in accordance with currently recorded pests of honey bee, it was reported that both adults and larvae small hive beetle were serious pests that weakened honey bee colonies or honey supers and as they multiply in huge numbers as well as their larvae tunnel through comb to eat brood, ruin stored honey, and ultimately destroy infested colonies. Ants were also reported to be most troublesome to honey bees and bee keeping sector and as they eats or carries off any comb contents, honey, pollen and brood [18]. Among ants, *Dorylus fulvus* was reported to be one of important honey bees' enemies that caused a serious problem [20]. Wax moths also reported to causes significance damage in colony of honeybees in several African countries [18].

Table 1. The species composition of honeybee pests recorded in Ari district

Pests of honey bee	Number of predators or parasitoids	Abundance (average no. insects/ 10g of honey sample)	Relative abundance (%)	Frequency (% of samples containing each species)	Rank
Small hive beetles	1000	27.78	76.63	94.44	1
Wasps	260	7.22	19.92	77.78	3
Wax moths	155	4.3	11.87	55.56	4
Ants	500	13.89	38.31	83.33	2
Spiders	115	3.19	8.81	50	5
Total	2030				

Table 2 Taxonomic position of honey bee pests recorded in Ari district

Common name of pests of honey bee	Scientific name	Family	Order	Type of the pest
Small hive beetles	*Aethina tumida*	Nitidulidae	Coleoptera	Predator
Oriental hornets; Wasps	*Vespa orientalis*	Vespidae	Hymenoptera	Parasitoid
Greater wax moths	*Galleria mellonella*	Pyralidae	Lepidoptera	Predator
Driver ants (safari ants)	*Dorylus species*	Formicidae	Hymenoptera	Predator
Black widow; Spiders	*Latrodectus mactan*	Theridiida	Araneae	Predator

3.2 Prevalence honeybee disease in Ari district

Table 3 demonstrated different types of diseases and the associated pathogens of honey bee that were recorded from honey bee samples collected from different apiaries of Ari district.

Accordingly, six types diseases caused by different species of pathogens (five identified and one non identified pathogens) belonging to three types pathogenic agents were recorded. Among these diseases caused by different pathogens, Chalk brood, other Virosis, European foulbrood and American foulbrood, respectively were the most frequently occurring as they appeared 83.33, 66.67, 58.33 and 55.56 percent's, respectively per 10 g of honey sample collected Ari district. But, Stone brood and Sac Brood Virus (SBV) were less frequently appearing as they occurred 41.67 % and 27.78%, respectively per 10 g of honey sample collected.

Generally, in terms of frequency of occurrence and the status (economic importance), the diseases of honey be recorded from honey samples collected from Ari district were found to be in the following orders, i.e., Chalk brood > Other virosis > European foulbrood > American foulbrood > American foulbrood > Sac Brood Virus (SBV) (Table 3). The different diseases and their causative agents of honey bee recorded from Ari district in the present study is partially in accordance with the report of previous researcher [18], in which the Honey bee (*Aphis mellenifera* L.) is indicated to be prone to infection by fungal, bacterial and protozoan pathogenic organisms and as honey bee diseases in Ethiopia include Chalkbrood diseases that is caused by pathogenic fungi, *Ascosphaera aphis*, Nosematosis that is caused by *Nosema apis* and amoeba that is caused by a single protozoa *Malpighamoeba mellificae*. Besides, the categorization and determination of their frequency occurrence and relative importance in Ari district the current study is in accordance with

the works or reports of previous scientists [11, 12, 3, 14, 15], in which all the identified species honey be diseases and their causative agents were shown cause significant loss of honey bee colony and honey production in different part of the world either indirectly by causing loss of honey (feed of the brood) or directly by affecting honey bee colony through being Entomo- pathogens of the different stages of honey bee.

Table 3. Prevalence honeybee diseases recorded in Ari district

Diseases of honey bee	Disease agents	Type	Number of samples infested	Frequency (% of samples containing each species)	Rank
European foulbrood	*Melissococcus pluton*	Bacterial	21	58.33	3
Chalk brood	*Ascosphera apis*	Fungal	30	83.33	1
American foulbrood	*Paenibacillus larvae*	Bacterial	20	55.56	4
Stone brood	*Aspergillus flavus*	Fungal	15	41.67	5
Sac brood Virus (SBV)	*Virus Picorna-like*	Viral	10	27.78	6
Other Virosis	Not distinguished	Viral	24	66.67	2

5. CONCLUSION

From the present survey five species of natural enemies (predators and parasitoids) belonging to four orders with in five families were recorded. Of these 76.63% accounts for small hive beetles from order Coleopteran with in the family Nitidulidae, followed by ants and wasps. Besides, six types diseases caused by different species of pathogens (five identified and one non identified pathogens) belonging to three types pathogenic agents were recorded. Among these diseases caused by different pathogens, Chalk brood, other Virosis, European foulbrood and American foulbrood, respectively were the most frequently occurring.

Generally, in terms of f the status (economic importance), the diseases of honey be recorded from honey samples collected from Ari district were found to be in the following orders, i.e., Chalk brood > Other virosis, > European foulbrood > American foulbrood > American foulbrood > Sac Brood Virus (SBV),' while the pests of honey be recorded were found to be in the following orders, i.e., Small hive beetles > Ants > Wasps > Wax moths > Spiders.

Accordingly along with other constraints, arthropod pests and diseases were found to be the most economically important constraints of honey colony establishment and honey production by farmers in the study areas of Jinka zones. Thus, it is important to design and implement safe and effective management strategies to reduce loss of honey colony and honey production, and hence income as well as food insecurity of poor farmers in the study area. Besides, provision of training to farmers and extension workers on safe handling of apiculture as well as management practices of arthropod pests and diseases of honey bee in the study area is urgently needed by any concerned bodies.

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