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PREVALENCE OF HONEY BEE PESTS AND PREDATORS IN APIARIES IN ARWOTCEK SUB-COUNTY, AMOLATAR DISTRICT

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DECLARATION

I, Innocent Ongodia, declare that the work compiled and presented in this dissertation is my personal work based on my knowledge and has never been submitted to any institution/University for award of any degree.

Innocent Ongodia

Signature .....

Date 2/3/2026

APPROVAL

This dissertation has been submitted for examination with approval of my supervisors:

Dr. John Bukenya

Signature ..... Date 3/3/2026.....

ACKNOWLEDGEMENTS

I am thankful to God for the gift of life, protection, and provision during the course of my study.

Dear Dr. John Bukenya, consider yourself heartily thanked as you were fully there for me during the course of my research study.

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TABLE OF CONTENTS

DECLARATION i

APPROVAL i

ACKNOWLEDGEMENTS iii

TABLE OF CONTENTS iv

LIST OF FIGURES vi

LIST OF TABLES vii

ACRONYMS AND ABBREVIATIONS viii

ABSTRACT ix

CHAPTER ONE 1

1.0 INTRODUCTION 1

1.1 Background 1

1.2 Problem statement 2

1.3 Objectives 2

1.3.1 General objective 2

1.3.2 Specific objectives 3

1.4 Research questions 3

1.5 Significance of study 3

CHAPTER TWO 4

2.0 LITERATURE REVIEW 4

2.1 Diversity of honey bees 4

2.2 Diversity and abundance of honey bee pests and predators 4

2.3 Distribution of pests and predators of honey bees 7

CHAPTER THREE 9

3.0 MATERIALS AND METHODS 9

3.1 Study Area 9

3.2 Study design 9
3.3 Data collection 9
3.4 Data analysis 10
CHAPTER FOUR 11
4.0 PRESENTATION OF RESULTS 11
4.1 Bee hives in Arwotcek sub-county 11
4.2 Diversity of bee pests and predators in apiaries 12
4.3 Abundance of pests and predators of honey bees in apiaries 12
CHAPTER FIVE 16
5.0 DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS 16
5.1 Discussion 16
5.2 Conclusions 17
5.3 Recommendations 18
REFERENCES 19
APPENDICES 24
Appendix I: Checklist 24
Appendix II: Researcher wearing personal protective equipment prior to data collection 26
Appendix III: Researcher in the field collecting data 27

LIST OF FIGURES

Figure 1: Location of Amolatar District showing details of the study sites (Extracted from Amolatar District Development Plan 2015). 9
Figure 2: Categories of bee hives in Arwotcek sub-county 11
Figure 3: Number of bee hives in the four parishes of Arwotcek sub-county 12
Figure 4: Variation in abundance of bee pests and predators 13
Figure 5: Variation in abundance of bee pests and predators from different parishes in Arwotcek sub-county 14

LIST OF TABLES

Table 1: Diversity index of different species of bee pests and predators in Arwotcek sub-county.....12
Table 2: Dunn's multi-comparison tests for abundance of bee pests and predators.....14

ACRONYMS AND ABBREVIATIONS

SDGs: Sustainable Development Goals

SHB: Small Hive Beetles

ABSTRACT

Honey bees (*Apis mellifera* L.) are among the most important pollinators of flowering plants, playing a key role in provision of both direct and indirect value to the agricultural economy and, consequently, the global economy. However, they are exposed to a wide range of threats such as pathogens and parasites, habitat fragmentation, pesticides, and environmental stressors, which have led to the loss of a significant number of colonies. A decline in their colony numbers is worrisome as it can cause extensive economic consequences. Due to this, there has been a substantial increase in research exploring the factors that pose threats to honey bee health. However, this research has not been conducted in all bee keeping zones, especially in developing countries. The present study found it thoughtful to investigate the prevalence of pests and predators of honey bees in apiaries in Arwotcek sub-county, Amolatar district found in the northern part of Uganda. The study used a descriptive cross-sectional design where purposive sampling was done among 40 beekeepers from four parishes (Ogenga, Aburkidi, Awac, and Anyamawele) in Arwotcek sub-county. The diversity of the bee pests and predators was computed using Shannon-weiner index while data on their abundance was analyzed using Kruskal-Wallis test at $\alpha=0.05$. The 40 bee keepers sampled had both colonized and uncolonized bee hives, but with more uncolonized hives in their apiaries. Four different kinds of bee pests and predators were recorded. These were ants, small hive beetles, varroa mites, and wax moths. The highest diversity of bee pests and predators was recorded in Awac parish (0.10877), followed by Ogenga (0.009178). Significant differences in the abundance of bee pests and predators (Kruskal-Wallis statistic=11.401, p=0.022, df=4, Kruskal-Wallis test) at $\alpha=0.05$ were registered. Small hive beetles were the most dominant in all the four parishes of Arwotcek sub-county followed by wax moths. In all the four parishes, the parishes where large numbers of bee pests and predators were registered are Ogenga and Aburkidi. These findings are pivotal as they portray a clear picture of the threats to beekeeping in Arwotcek sub-county. This is the first study at the sub-county level to determine the diversity and abundance of bee pests and predators in four beekeeping villages of Arwotcek sub-county. It is thus paramount that adequate knowledge on the presence of these pests and predators is generated, not only in Arwotcek sub-county but also in other beekeeping communities in Amolatar district. However, since the current study did not consider the measures being taken by bee keepers in Arwotcek sub-county, there is a need for a study focusing on the bee pest and predator prevention measures.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Western honey bees (*Apis mellifera* L.) are among the most important pollinators of flowering plants, playing a key role in food production and natural ecosystem maintenance (Lorenzo-Felipe et al., 2020). They are eusocial insects generally managed as colonies of 10,000–80,000 individuals including several hundred males present during the spring and summer seasons, and one queen who is the only reproductive female of the colony (Cunningham et al., 2022). Through their pollination services, honey bees (*Apis mellifera* L.) provide both direct and indirect value to the agricultural economy and, consequently, the global economy (Feuerbacher et al., 2024; Jordan et al., 2021). For example, they play a critical role in pollinating crops contributing an estimated $14.6 billion annually in the US economy (Calderone, 2012) and a major fraction of the $175 billion global value of pollination (Gallai et al., 2009). Due to this link between honey bees and global food security, the decline of managed honey bees and the loss of wild pollinators are of increasing concern (Genersch, 2010). However, honey bees are exposed to a wide range of biotic and abiotic stressors such as pathogens and parasites, habitat fragmentation, pesticides, and environmental stressors, which have led to the loss of a significant number of colonies (Requier et al., 2018). They encounter these stressors while conducting a variety of tasks from nursing as young adults to foraging later in life (Cunningham et al., 2022). They can also come in contact with environmental matrices including plant, air, water, and soil which may skyrocket the chances of their exposure to contaminants and pathogens that adhere to their body or are ingested during nectar and pollen collection or water uptake (Cunningham et al., 2022).

Honey bees are also susceptible to a variety of diseases (Genersch, 2010). Despite all this, it is worthy to emphasize that bee parasites have been considered as one of the main drivers for bee colony losses worldwide (Smith et al., 2013). Among the current threats, different species of parasites belonging to the family Trypanosomatidae (Euglenozoa, Kinetoplastea) have been found infecting honey bees and wild bees (Buendía-Abad et al., 2022). Currently, it is generally accepted that losses of honey bee colonies are a consequence of the synergy and interaction of multiple contributing factors, with the ectoparasitic mite *Varroa destructor* playing a major role (Hristov et al., 2020). Other than these mites, there are other honey bees diseases and parasites that have been shown to play a significant role in increased honey bee

colony mortality and in the described colony losses (Genersch, 2010). These include the bee pathogenic viruses acute bee paralysis virus (ABPV) and deformed wing virus (DWV) (Genersch, 2010), Israeli acute paralysis virus (IAPV) which has been identified as a marker of dramatic colony losses termed colony collapse disorder (CCD) in the USA (VanEngelsdorp et al., 2009), the microsporidium *Nosema ceranae* causing severe colony mortality in Spain (Higes et al., 2008). *Melissococcus plutonius*, the etiological agent of European Foulbrood, is of increasing concern in Switzerland and the UK (Roetschi et al., 2008), and Paenibacillus larvae, which has been causing American Foulbrood, is causing economic losses to beekeepers worldwide (Genersch, 2008). The loss of these honey bee colonies is therefore perilous as it can cause extensive economic consequences, so there has been a substantial increase in research focused on investigating the factors that pose threats to honey bee health (Neov et al., 2019). It is against this background that the present study found it thoughtful to investigate the prevalence of pests and predators of honey bees in apiaries. This present study was conducted in Arwotcek sub-county, Amolatar district found in the northern part of Uganda.

1.2 Problem statement

Honey bees play an immeasurable role in the environment through their hive products. They also provide pollination services, which contribute directly and indirectly to the agricultural economy and, consequently, the global economy (Feuerbacher et al., 2024). However, there have been growing concerns regarding the threats to these pertinent pollinators. These threats are all directly or indirectly related to human activities such as habitat fragmentation and habitat loss, unsustainable honey hunting, biological invasions, and intensive use of pesticides (Freitas et al., 2009). The biological invasions of honey bees are diverse, and they include parasites. Put together, these threats to honey bees cause losses to beekeepers. It is important to highlight that a strong body of literature exists regarding bee pests. However, there is localized information in areas where apiculture is greatly expanding, thus presenting a knowledge vacuum. In Uganda, such areas where apiculture is expanding, are numerous. The present study, however, considered Arwotcek sub-county found in Amolatar district, Northern Uganda, to investigate pests and predators of honey bees.

1.3 Objectives

1.3.1 General objective

To investigate the prevalence of pests and predators of honey bees in apiaries in Arwotcek sub-county, Amolatar district as a basis for supporting the health of apiculture enterprises.

1.3.2 Specific objectives

i. To assess the abundance of pests and predators of honey bees in apiaries in Arwotcek sub-county.
ii. To assess the sex-difference of pests and predators of honey bees in apiaries in Arwotcek sub-county.

1.4 Research questions

i. What is the diversity of pests and predators of honey bees in apiaries in Arwotcek sub-county?
ii. What is the abundance of pests and predators of honey bees in apiaries in Arwotcek sub-county?
iii. What is the sex-difference of pests and predators of honey bees in apiaries in Arwotcek sub-county?

1.5 Significance of study

To date, there is no available data pertaining to the population of bee pests and predators in Amolatar district. Yet beekeeping is a lucrative business that has been taken up by the people in Amolatar district. The current study will thus provide empirical data on which bee pests and predators are present in Amolatar district. This information is important especially to beekeepers as it will create awareness on which pests and predators cause devastating effects to honey bees such as reduction and death of colonies. Secondly, through the data generated, the study will help in ensuring effective bee keeping practices against bee pests and predators. This information will contribute to the attainment of SDG 1 which emphasizes an end to poverty and SDG 2 which stresses a need for zero hunger.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Diversity of honey bees

Globally there are approximately 25,000 described bee species and there are estimated to be 40,000 bee species existing in total (Nkoba et al., 2016). The first honeybees are believed to have evolved from a wasp-like ancestor known as spheciod about 100 million years ago (Hepburn & Radloff, 2013). Honeybees (*Apis mellifera*) are the most widespread bee species in the African savanna ecosystem (Moritz et al., 2005). The intensity of both apiculture and meliponiculture influences honeybees and stingless bees habitat and distribution (Chakuya et al., 2022). An understanding of honeybees and stingless bees biology, ecology, diversity, habitat and distribution is critical to ensure effective conservation (Fitzpatrick et al., 2007). Honeybees are critical in pollinating almost three quarters of the world's flowering plants (Gupta et al., 2014).

The first scientific reports on African races of honeybees were given at the beginning of the 19th century (Gupta et al., 2014). Most reports on honeybees within the savanna ecosystem were mere short, imprecise descriptions and no diagnosis was made (Chakuya et al., 2022). Literature reveals that there are 12 subspecies of *A. mellifera* which are found within the savanna ecosystem (Gupta et al., 2014). The geographical races of honeybees are a result of natural selection and they are not the result of choice or breeding (Gupta et al., 2014). The eastern, western and southern part of the African savanna ecosystem is dominated by East African bees (*A.m. scutellata*) and Western African bees (*A. m. adansonii*) (Ascher & Pickering, 2011). These species are smaller compared to the European honeybees and their colonies have more swarms (Meixner, 2010). The Egyptian bee (*A. mellifera lamarckii*) is a relatively defensive race commonly found in the lower Nile valley and has black with yellow abdominal bands (Chakuya et al., 2022). The Tellian bees (*A. m. intermissa*) were found in marginal areas of the Sahel and savanna ecosystem (Michener, 2007). *Apis mellifera intermissa* is black and produces more propolis than *A.m. scutellata. Apis mellifera scutellata* is the most commonly used species in beekeeping due to its ability to produce more honey, swarms less and it is not very aggressive like the *A. m. lamarckii* (Gupta et al., 2014).

2.2 Diversity and abundance of honey bee pests and predators

Pathogens and pests are known to cause annual colony losses and have been linked, hypothetically, to long-term declines in bee populations (Smith et al., 2013). Historical evidences from various countries suggest that there is a significant relationship between the

success of apiculture industry and the control of honey bee pests (Gebretsadik, 2016). Practical knowledge on the identifications of honeybee pests that endangers the life and products of honeybees and developing appropriate control measures is largely a question of success in the beekeeping sector (Gebretsadik, 2016). Some of the pests and predators of honey bees include;

Varroa destructor belongs to the genus *Varroa* which is currently represented by at least four species of obligate ectoparasitic mites of honey bees such as *Varroa jacobsoni* Oudemans (Anderson, 2000), and *V. destructor* (Anderson & Trueman, 2000).

V. destructor belongs to the genus Varroa which is currently represented by at least four species of obligate ectoparasitic mites of honey bees which are; *Varroa jacobsoni* Oudemans (Anderson, 2000), Varroa underwoodi (Delfinado-Baker and Agarwal, 1987), *Varroa rindereri* (De Guzman and Delfinado-Baker , 1996), and *V. destructor* (Anderson & Trueman, 2000).

The ectoparasite *V. destructor* is intimately linked to its host, the honey bee and all life stages of the mites take place on bees and/or in the colony, and no free-living, bee-independent stages do exist (Genersch, 2010). The pathology of *V. destructor* at the individual insect level is in particular determined by (1) the feeding activities of the mites (i.e. injuring the cuticle of pupae and adults, sucking substantial amounts of haemolymph), and (2) vectored viruses (Genersch, 2010). Recent studies revealed that mite infestation during pupal development might also have an effect on the immune capacity of the parasitized pupae and even on the adult bees (Genersch, 2010).

Evidence exists that *V. destructor* can cause activation of endogenous virus infection also leading to overt disease outbreaks as a consequence of the immune suppression in pupae and adult bees which are/ were parasitized during their ontogenetic development (Yang & Cox-Foster, 2005).

Amphibians; Beekeeping in tropical climates frequently suffers from damage caused by amphibians: toads including *Bufo melanostictus* and *Kaloula pulchra* and frogs including *Rana limnochari*s and *Rana tigrina* (Ritter & Akratanakul, 2006). Continuous predation by toads and frogs, if not prevented, results in a loss of colony strength and while colonies with moderate or larger worker populations can withstand the predation and subsequently recover their full strength, weaker colonies are at considerable risk. Toads and frogs have similar attacking patterns (Ritter & Akratanakul, 2006).

Mammals; Many groups of mammals may be considered as enemies of the honey bee and in general, they prey on colonies for honey and/or brood; some attacks are purely accidental or

the result of animal curiosity (Ritter & Akratanakul, 2006).

Wax moths (*Galleria mellonella* and *Achroia grisella*); The term wax moth is a common name which refers to different species of moths that invade, attack, and damage honeybee colonies and hive products (Ellis et al., 2013). They are also known as the bee moth, or the wax (or bee) miller (Ellis et al., 2013). *Galleria mellonella* is a member of the Galleriinae subfamily within the family Pyralidae of Lepidopteran order (Kwadha et al., 2017). The GWM is considered one of the most important pests of honeybee products owing to the destructive feeding habit of its larva (Williams, 1997). Damage occurs as the larvae create silk-lined tunnels through the hexagonal cell walls and over the comb surface (Kwadha et al., 2017). Moreover, large scale infestation of colonies by larvae of the greater wax moth often lead to colony loss, absconding, and reduction in the size of the migratory bee swarms (Gulati & Kaushik, 2004). Wax moths (*Galleria mellonella* and *Achroia grisella*) attack colonies during the warm periods of the year (Gebretsadik, 2016).

Tropilaelaps mites; these are much smaller than varroa mites, although the trained unaided eye can still see them and in all their immature stage, they live within the brood cells of the bees, feeding on the brood's haemolymph (Ritter & Akratanakul, 2006). The damage caused to colonies by Tropilaelaps infestation is similar to that brought about by varroa and the injuries inflicted on individual bees and bee brood are essentially the same (Ritter & Akratanakul, 2006). The abdomen of bees surviving mite attacks is reduced in size, and they have a shorter life-span than healthy bees (Ritter & Akratanakul, 2006).

Acarapis woodi; *A. woodi* is a very small mite (0.1 m) species that lives and breeds within the thoracic tracheae of adult bees. It infests the tracheal system of adult bees, queens, workers and drones, which are all equally susceptible to its attacks (Ritter & Akratanakul, 2006).

Crab spiders; Spiders (Araneae: Arthropoda: Chelicerata: Arachnida) are among the most frequent and abundant predators in the terrestrial ecosystem throughout the world (Singh & Singh, 2021). These spiders are commonly known as the crab spiders, flower spiders or flower crab spiders because of crab-like appearance (Singh & Singh, 2021).

Small hive beetle (SHB); Originally, this beetle (*Aethina tumida*), was only found in Africa, south of the SaharaOnly weak colonies or storage combs are affected (Ritter & Akratanakul, 2006). This beetle lives and multiplies within and outside bee colonies and as well deposits larger nests of eggs within a bee colony, in fissures and recesses out of reach of the bees (Ritter & Akratanakul, 2006). There they form eating canals and destroy the cell caps, and the honey starts to ferment (Ritter & Akratanakul, 2006).

Ants; Ants are highly social insects and will attack the hives en masse, taking virtually

everything in them: dead or alive adult bees, the brood and honey (Ritter & Akratanakul, 2006). All types of ants (driver, tailor, black, red, brown, large or small) are dangerous to the hive as they eat sweets such as nectar, honey, sugar and the bee's body (Gebretsadik, 2016). Many ant genera and species are reported to cause problems to both traditional beekeeping with *A. cerana* and to modern beekeeping with *Apis. mellifera* and among the most frequently recorded species are the weaver ant (*Oecophylla smaragdina*), the black ant (*Monomorium indicum*), *Monomorium destructor*, *Oligomyrmex* spp., *Dorylus* spp., the fire ants (*Solenopsis* spp.) and *Formica* spp (Ritter & Akratanakul, 2006).

Reptiles; Among the reptile species that are regularly recorded as present in commercial apiaries are the tokay (*Gecko gecko*), which can be as much as 35 cm long, *Calotes* spp., *Acanthosaura* spp and the skink *Sphenomorphus* spp (Ritter & Akratanakul, 2006). Arboreal reptiles such as many geckos and skinks can attack bees either near the hive entrance or on the limbs of flowering trees visited by forager bees (Ritter & Akratanakul, 2006). Smaller lizards, such as the gecko *Hemidactylus frenatus*, often hide in the empty space between the outer and inner covers of the hive and in tropical areas, this type of predator frequently causes the sudden loss of the queen from a weak colony (Ritter & Akratanakul, 2006).

Birds; Birds prey upon many insect species and honey bees are no exception and once airborne, the bees are virtually defenseless against birds, several species of which can tolerate their venomous stinging defense (Ritter & Akratanakul, 2006). The heavy traffic of bees flying in and out of the hives of commercial apiaries provides an exceptional opportunity for insectivorous birds, large numbers of which may be attracted by this situation (Ritter & Akratanakul, 2006). Birds that have been listed as attacking honey bees in Asia include bee-eaters (*Merops apiaster*, *Merops orientalis*), swifts (*Cypselus* spp., *Apus* spp.), drongos (*Dicurus* spp.) shrikes (*Lanius* spp.), woodpeckers (*Picus* spp.) and honey guides (Indicatoridae) (Ritter & Akratanakul, 2006).

2.3 Distribution of pests and predators of honey bees

In a study done in Uganda, many bee pests were detected in honeybee colonies in both the eastern and western highland AEZs, and these included; the rat (*Graphiurus* sp.), lizards (*Agama* sp.), small hive beetle SHB (*Aethina tumida*), wax moth (*Galleria mellonella*) and ants (*Dorylus* sp.) (Chemurot et al., 2018). In the same study, the infestation level of wax moths in beehives was significantly higher during the wet season compared to dry season and also varied significantly across different dominant vegetation types (Chemurot et al., 2018).

Additionally, colonies under Eucalyptus/pine vegetation type had significantly higher wax

moths infestation levels than all other vegetation types (Chemurot et al., 2018).In another study carried out in Ethiopia, there were eleven major pest and predators reported to be attacking honeybees and their hives in the study area (Gebretsadik, 2016). The findings of this study showed that ants were the most dominant pests and wasps were the least. . The pressure of pests and predators to honey bees varied according to the seasons as the rainy season/summer had the highest pressure of pest and predators (Gebretsadik, 2016).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

The study was carried out in Arwotcek sub-county, Amolatar district (Figure 1). Amolatar district is located in Northern Uganda with latitude 1.6333° or 1° 38' north and longitude 32.8333° or 32° 50' east, approximately 156 km from Kampala via Lake Kyoga through Nakasangola and borders Apac to the North, Dokolo and Kaberamido in the East, Buyende and Kayunga in the South and Nakasongola in the West (DDP 2015).

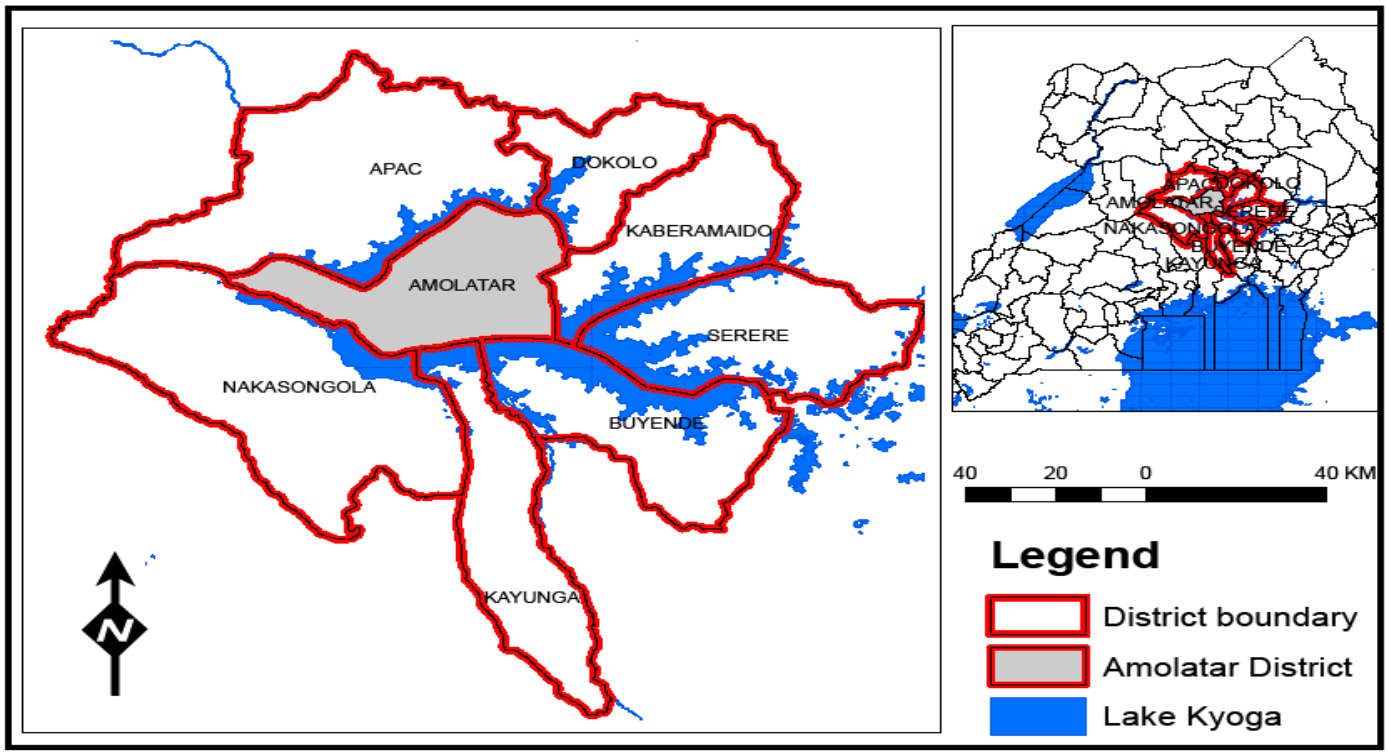


Figure 1: Location of Amolatar District showing details of the study sites (Extracted from Amolatar District Development Plan 2015).

3.2 Study design

The study used a descriptive cross-sectional study. Before conducting surveys, discussions were held with District Entomology office, so as to select sites and apiaries. Based on the information of the District Entomology office, 40 beekeepers were purposively selected from five selected villages in Arwotcek sub-county.

3.3 Data collection

Prior to data collection, a pre-test and recognizance survey were conducted to see the effectiveness of the questionnaire for the study. This was followed by external/ visual

observation of the apiary management, and internal inspection of the selected hives. Information of interest will then be obtained for the selected respondents using a check list.

3.4 Data analysis

The diversity of pests and predators was determined using Shannon-weiner index (**$H = -\Sigma pi * \ln(pi)$**) (Shannon & Weaver, 1949). Data on abundance of pests and predators were analyzed using Kruskall-Wallis test at $\alpha=0.05$. Data on sex-ratio of pests and predators were also analyzed using Kruskall-Wallis test at $\alpha=0.05$. All inferential statistics were done using IBM SPSS Statistics for Windows, Version 20.0 (Armonk, NY: IBM Corp) while data visualization was performed on Graphpad Prism V8.0.2.

CHAPTER FOUR

4.0 PRESENTATION OF RESULTS

4.1 Bee hives in Arwotcek sub-county

A survey of different pests and predators attacking the colonies of honey bees was conducted in 40 apiaries in four parishes (Ogenga, Aburkidi, Awac, and Anyamawele) in Arwotcek sub-county, Amolatar district (Figure 1). These respondents had two different categories of bee hives. It is key to report that uncolonized bee hives were more common in most of the parishes in Arwotcek sub-county compared to colonized bee hives (Figure 2). In the four parishes sampled, more bee hives were recorded in Awac followed by Aburkidi (Figure 3).

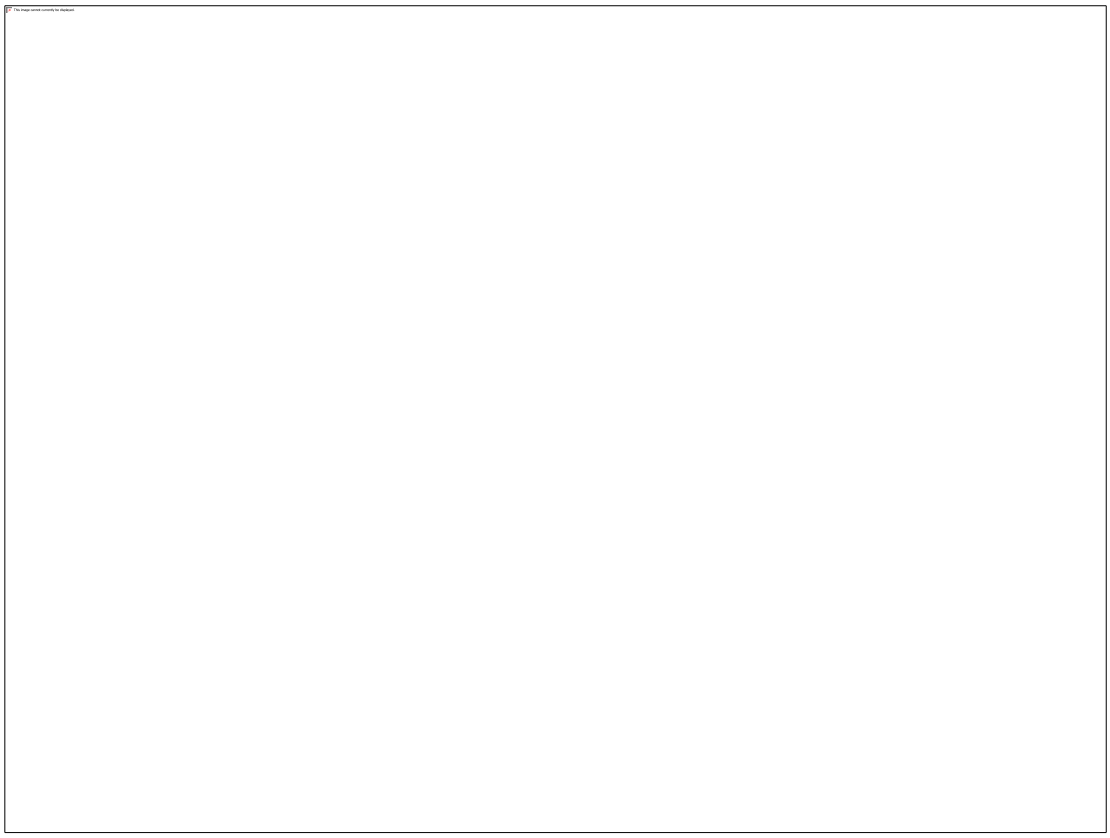


Figure 2: Categories of bee hives in Arwotcek sub-county

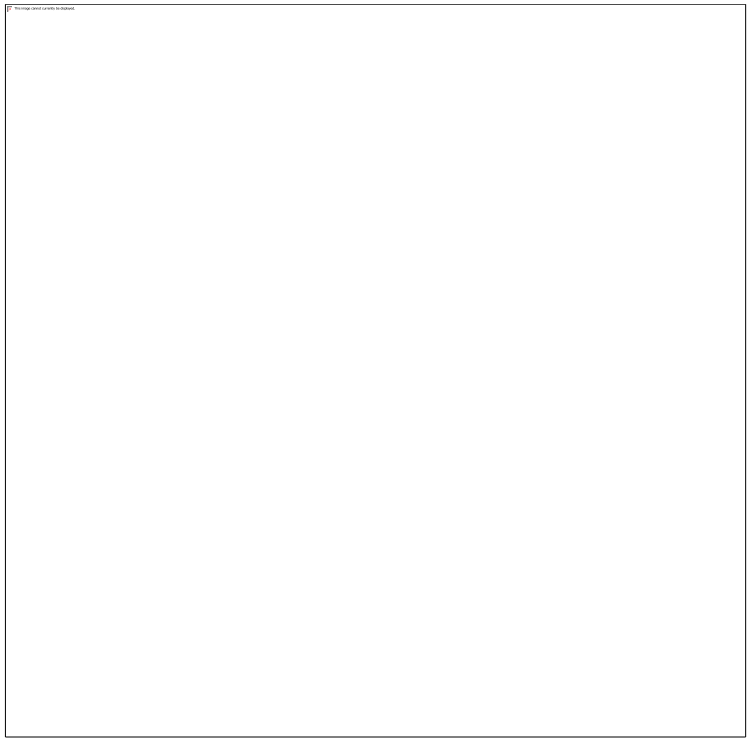


Figure 3: Number of bee hives in the four parishes of Arwotcek sub-county

4.2 Diversity of bee pests and predators in apiaries.

Among the different communities in Arwotcek sub-county, the highest species diversity was recorded in Awac parish, followed by Ogenga (Table 1).

Table 1: Diversity index of different species of bee pests and predators in Arwotcek sub-county

	Communities			
	Ogenga	Aburkidi	Awac	Anyamawele
Shannon Diversity Index (H) values	0.009178	-0.51086	0.10877	-0.28583

4.3 Abundance of pests and predators of honey bees in apiaries

There was a statistically significant difference in the abundance of bee pests and predators (Kruskal-Wallis statistic=11.401, p=0.022, df=4, Kruskal-Wallis test) at α=0.05. The post-hoc results revealed that the only significant pair of bee pests and predators (Table 2) were: others-wax moths, others-small hive beetles, varroa mites-small hive beetles, and ants-small hive beetles (Dunn's multiple comparison test, α=0.05).

Among all the bee pests and predators investigated, it were the small hive beetles that had the highest abundance at $\alpha=0.05$ followed by wax moths (Figure 4). Small hive beetles were the most dominant in all the four parishes of Arwotcek sub-county followed by wax moths (Figure 5). In all the four parishes, the parishes where large numbers of bee pests and predators were registered are Ogenga and Aburkidi.

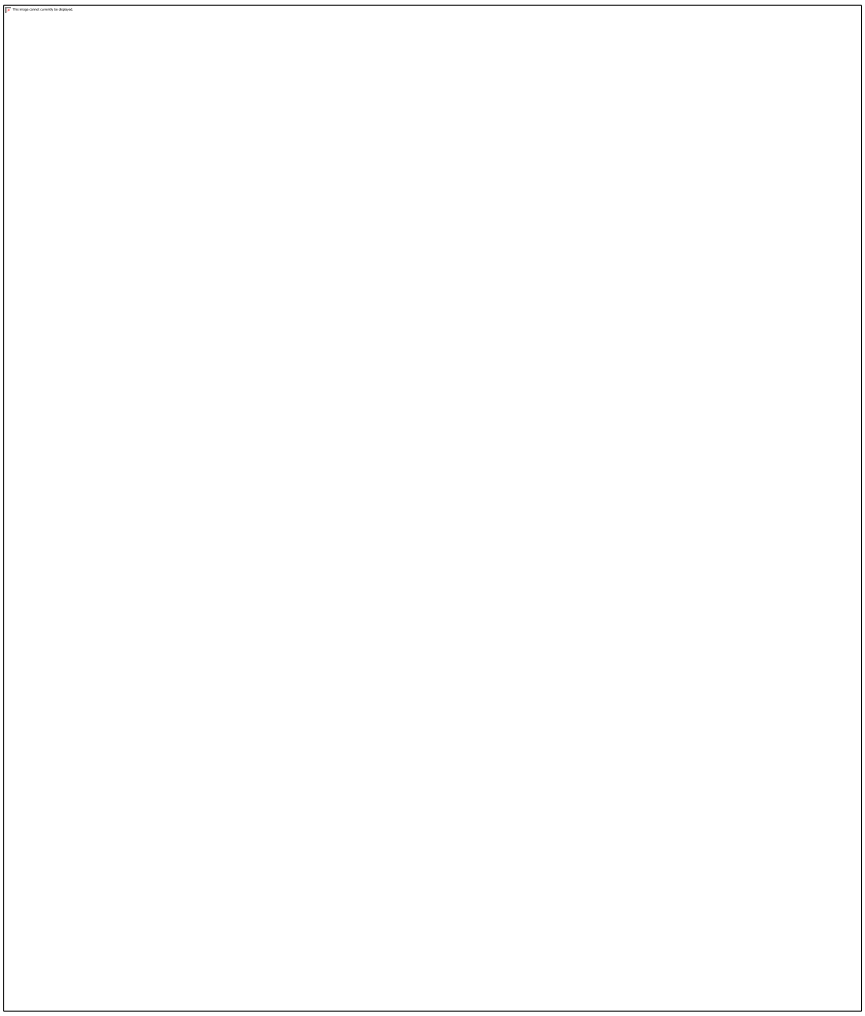


Figure 4: Variation in abundance of bee pests and predators

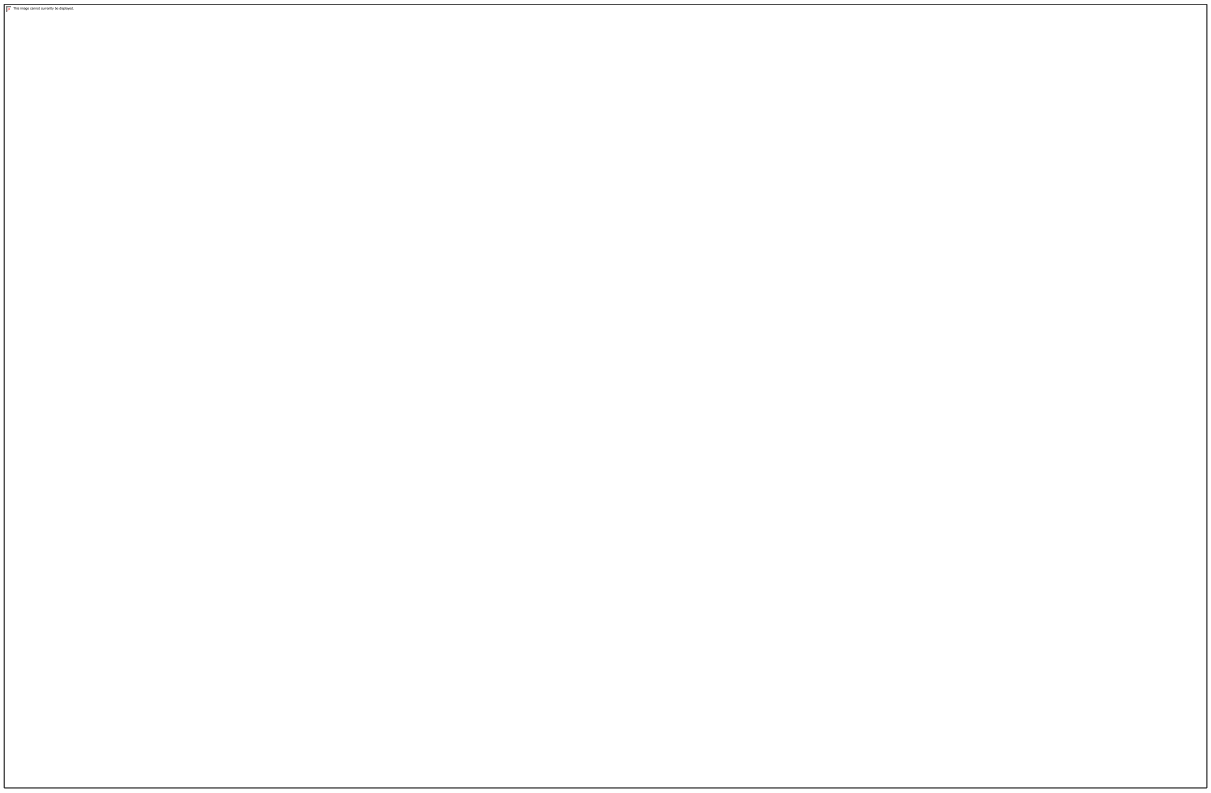


Figure 5: Variation in abundance of bee pests and predators from different parishes in Arwotcek sub-county

Table 2: Dunn's multi-comparison tests for abundance of bee pests and predators

Sample1-Sample2	**Test Statistic**	**Std error**	**Std Test statistic**	**Sig**	**Adj. Sig**
Others-Veroa mites	-0.75	4.043	-0.186	0.853	1.000
Others-Ants	3.125	4.043	0.773	0.44	1.000
Others-Wax moths	-8.125	4.043	-2.01	0.044	0.444
Others-small hive beetles	-11.125	4.043	-2.752	0.006	0.059
Veroa mites-Ants	2.375	4.043	0.588	0.557	1.000
Veroa mites-wax moths	-7.375	4.043	-1.824	0.068	0.681
Veroa mites-small hive beetles	10.375	4.043	2.566	0.01	0.103
Ants-wax moths	-5	4.043	-1.237	0.216	1.000
Ants-small hive beetles	-8	4.043	-1.979	0.048	0.478
Wax moths-small hive	3	4.043	0.742	0.458	1.000

beetles

Each row tests the null hypothesis that the Sample 1 and Sample 2 distribution are the same.

Asymptotic significance (2-sided tests) are displayed. Significance level is 0.05

CHAPTER FIVE

5.0 DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Discussion

Bees are of commercial value today as pollinators of forests, horticultural and agricultural crops, and for their marketable products such as honey and wax (Sarwar, 2016). The most important species for bee keeping is the *Apis mellifera scutellata* Lepeletier (Sarwar, 2016). This current study focused on the diversity and abundance of bee pests and predators. Bee pests and predators are known to cause great damage to the life and the products of honeybees by causing disappearance and migration (Tesfaye et al., 2017). Furthermore, they affect honey bee populations by causing an abrupt collapse in their populations (Peña-Chora et al., 2023). The presence of pests and predators in *A. mellifera* has been a triggering factor for the phenomenon known as colony collapse disorder (CCD), which has been shown to significantly compromise the survival of *A. mellifera* (VanEngelsdorp et al., 2009).

The present study reported wax moths, small hive beetles, mites, and ants as some of the pests and predators that invaded honey bees in their apiaries. This finding aligns with some studies in Uganda that have reported the prevalence of small hive beetles (Agaba et al., 2016), and varroa mites (Akol et al., 2016). Other studies that agree with the present finding reported ants, mites, and wax moths were among the honey bee pests and predators (Sharma et al., 2013). Another study of Tesfaye et al., (2017) also reported ants, beetles, and wax moths as being some of the major bee enemies. Furthermore, other surveys in Ethiopia reported ants, beetles, and wax moths as being the most dangerous pests and predators of bees (Desalegn, 2001; Kebede & Lemma, 2007; Shenkute et al., 2012).

The diversity of bee pests and predators was higher in some geographical regions, a finding that is similar to that of Sharma et al., (2013). It is key to report that some of the bee pests and predators such as mites, registered in the present study have been considered as pathogens that cause the most damage to the beekeeping industry globally (Traynor et al., 2020). This is because these mites feed upon the hemolymph and fat body of honeybees, inhibit their immune responses, and shorten their lifespan (Reyes-Quintana et al., 2019). Mites being less dominant in most of the parishes of Arwotcek sub-county is in agreement with the study findings of Martínez Puc et al., (2011) where a low prevalence of mites was registered in different regions. Mites being less abundant may be due to using unreliable methods for their determination. This is because honey bees occasionally move to nearby colonies when returning from foraging trips, carrying mites with them (Goodwin et al.,

2006). Additionally, the low mite infestation levels of honey bee colonies in the present study may be the results of factors such as different treatment strategies implemented in beekeeping operations (Correa-Benítez et al., 2023).

Some pests and pathogens were prevalent and abundant (small hive beetles) in some areas but not in others. The present study reported small hive beetles as being the most dominant. However, the study of Correa-Benítez et al., (2023) recorded varroa mites as being the most common enemies of honey bees in Mexico. This difference may be attributed to geographical region, since different bee pests and predators are known to thrive in particular areas due to conditions that differently favor their presence and abundance (Correa-Benítez et al., 2023).

The finding of small hive beetles (SHB) being key pests and predators of bees has also been reported in a study of Correa-Benítez et al., (2023), where SHB were the prominent pests and scavengers of bee colonies. SHB have been reported to cause bees to abandon their hives and search for new habitats (Neumann & Ellis, 2008). The significant difference ($p<0.05$) in the abundance of bee pests and predators in the communities of Arwotcek sub-county is in agreement with a study of Correa-Benítez et al., (2023), where significant differences in the prevalence of bee pests and predators were recorded. SHB being highly dominant in the bee colonies may be attributed to the warm conditions in Arwotcek sub-county, Amolatar district, that favor their dispersion (Bulacio Cagnolo et al., 2023).

The presence of these bee pests and predators in apiaries in Northern Uganda is worrisome, as it may account for losses in total honey production (Edessa, 2005) in the region. This is supported by historical evidence from various countries, which suggests that there is a significant relationship between the success of apiculture industry and the control of honey bee pests (Veitch & Clout, 2002).

5.2 Conclusions

The beekeeping industry in Arwotcek sub-county is affected by pests and predators that impact the health and productivity of honey bee colonies. It is paramount to generate adequate knowledge on the presence of these pests and predators not only in Arwotcek sub-county but also in other beekeeping communities in Amolatar district. This is the first study at the sub-county level to determine the diversity and abundance of bee pests and predators in four beekeeping villages of Arwotcek sub-county. The study revealed that the most common pests and predators of honey bees in Arwotcek sub-county are small hive beetles and wax moths. SHB are particularly highly abundant in Ogenga and Aburkidi parishes, which thus calls for further investigation because of the high beekeeping importance of these two

parishes.

5.3 Recommendations

There is a dire need for adoption or implementation of good beekeeping practices that can help to reduce the invasion of bee hives by bee pests and predators. Controlling the bee pests and predators may also require immense knowledge of recognizing and detecting the different damage causing pests and predators.

Since the current study did not consider the measures being taken by bee keepers in Arwotcek sub-county, there is a need for a study focusing on the bee pest and predator prevention measures.

Intense surveys at different times of the year that cover more pests and predators are needed to provide more accurate information on the health status of honey bees in Arwotcek sub-county.

Studies on the actual impact that pests and predators may have on the health and productivity of honey bee colonies are also warranted. This is because such information will help elucidate the dynamics of different pests and predators, as well as develop management strategies and policies of pest and predator control to sustain healthy bee colonies.

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APPENDICES

Appendix I: Checklist

a) Inspection of bee hives and pests Nature of apiary: …….
b) Type of bee hives: …….
c) Season of serious damage of pests and predators in the villages
d) Major honeybee pests and predators in the villages
e) Date and Time of data collection. …….

1. Bee Predator/Pest Identification:

Species observed (Check all that apply):

☐ Varroa Mites *(Varroa distructor)*

☐ Small Hive Beetles *(Aethina tumida)*

☐ Ants

☐ Wax Moths (*Galleria mollonella)*

Others specify ……

2. Prevelance of Honey bee pests and predators:

Total number of pests/predators observed per hive inspected by species: _____

(i) Varroa Mites *(Varroa distructor)* _____

(ii) Small Hive Beetles *(Aethina tumida)* _____

(iii) Ants _____

(i) Wax Moths (*Galleria mollonella)* _____

(iv) Others specify. ……..

3. Average number of Honey bee pests and predators observed in all the villages sampled:

(ii) Varroa Mites *(Varroa distructor)*: _____

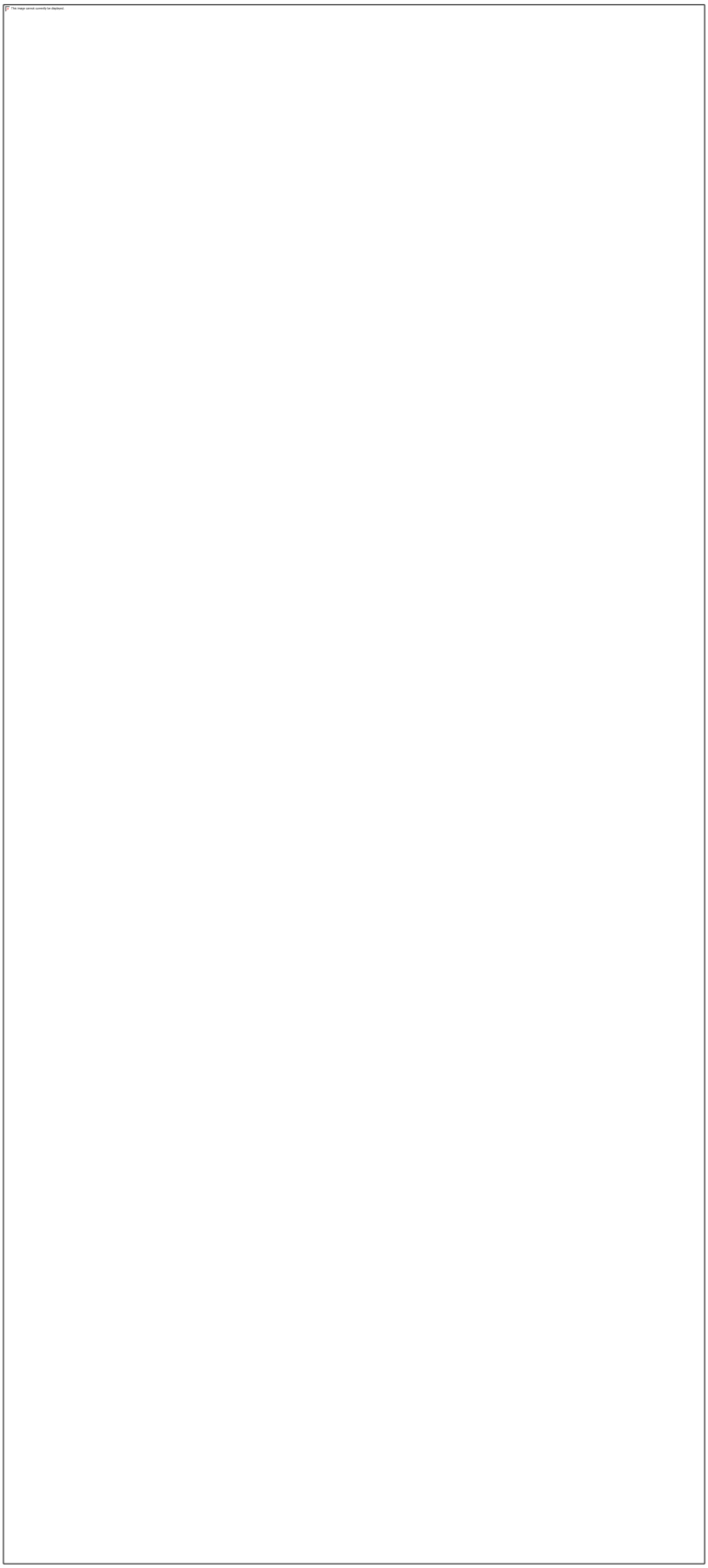
(iii) Small Hive Beetles *(Aethina tumida)*: _____

(iv) Ants: _____

(v) Wax Moths (*Galleria mollonella)* _____

(vi) Others specify: _____

Appendix II: Researcher wearing personal protective equipment prior to data collection



Appendix III: Researcher in the field collecting data

