

**COMPARATIVE ASSESSMENT OF ECTOPARASITIC INFESTATIONS IN URBAN  
AND RURAL LIVESTOCK PRODUCTION SYSTEMS IN THE GREATER ACCRA AND  
EASTERN REGIONS OF GHANA**

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**DECLARATION**

I do hereby declare that apart from references to the work of other investigations which I duly acknowledged, the work presented in this thesis is original and it was carried out under the joint supervision of Dr. Fred Aboagye-Antwi and Dr. Mrs. Delphina A. M. Adabie-Gomez.

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## ABSTRACT

Livestock are important contributors to food production in Ghana, providing meat, milk and a source of income for many. Rearing of livestock is practiced by the majority of the farming communities in which they are considered as an investment and insurance against risk and to meet seasonal and emergency purchases such as food crop, improved seed, fertilizers and medicine. However, production of animals is constrained by compound effects of parasitic infestation, diseases, poor feeding and poor management. Parasitic infection is among the major problems of domestic animals, causing serious economic impact. Results obtained by previous researchers indicate that external parasites of livestock are widely distributed. Variable degrees of prevalence in Ghana are the cause of serious economic loss to the farming community, tanning and leather industry and the country as a whole and therefore demand effective control measures. Generally, there has been limited research work on the effects of arthropod ectoparasite infestations on livestock productivity in Ghana therefore there is the need to compare arthropod ectoparasitic infestations in rural and urban livestock (cattle, sheep and goats) production systems in Ghana. . The study was aimed at gathering preliminary information on ectoparasites species, their distribution and their preferred sites of attachment on various livestock hosts in the study sites. At the end of the study, more ticks were sampled from the rural sites than the urban sites and the most sampled tick species was the *Amblyomma variegatum*. The most preferred site of attachment was the abdomen and the least was the head region. Fleas and lice on the small ruminants were also sampled but were relatively low in numbers due to the regular application of insecticides by the farmers. Comparatively, the numbers of ticks species *Amblyomma variegatum*, *Rhipicephalus (Boophilus) microplus*, *Hyalomma rufipes* and the flea species *Ctenocephalides canis* were not significantly higher in rural areas than the urban areas ( $p > 0.05$ ). The numbers of the *Damalinea*

*spp* and *Rhipicephalus decoloratus* were also not significantly different in rural sites and urban sites ( $p > 0.05$ ). Certain practices like keeping the livestock in unclean shelters, low interactions between the farmers and veterinary doctors, and the lack of adequate cleansing urine and faeces on the livestock were responsible for the high incidence of ectoparasites on livestock in the rural areas than the urban areas. It is recommended that the farmers should be educated more on the need to keep their holding places for the animals clean and to interact more often with the veterinary personnel to have a better perspective on the need to keep the animals in good condition for better economic returns. There should be provision of irrigation facilities that would aid the farmers in cleansing of the livestock to reduce conditions that make the animals prone to ectoparasite infestations.

**DEDICATION**

I hereby dedicate this research work to all early career research scientists in the field of medical and veterinary entomology.

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### LIST OF ABBREVIATIONS

BCS	Body Condition Score
CCHFV	Crimean-Congo Hemorrhagic Fever
CCHFV	Crimean-Congo Hemorrhagic Fever Virus
CDC	Centre for Disease Control
COXI	Cytochrome Oxidase Sub-unit One
ELISA	Enzyme Link Immunosorbent Assay
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GPS	Global Positioning System
IFAT	Indirect Fluorescent Antibody Test
ITS2	Internal Transcribed Spacer Two
LIPREC	Livestock and Poultry Research Centre
PCR	Polymerase Chain Reaction
SFGR	Spotted Fever Group <i>Rickettsia</i>
TBD	Tick-borne Diseases
TBE	Tick-Borne Encephalitis
TBEV	Tick-Borne Encephalitis Virus
TGR	Transitional Group

## CHAPTER ONE

### 1.0 INTRODUCTION

#### 1.1 Background

Agricultural livestock systems are increasingly structured in long market chains employing around 1.3 billion individuals worldwide and directly promoting the livelihoods of 600 million small-scale farmers in developing nations (Thornton, 2010). Farm animals provide a year-round stream of vital food products and are a significant source of income from government and export income, (Chambers and Conway, 1992) and provide money for other needs. In most rural areas, the sale of animals and their goods is often the only source of revenue.

Approximately 1.54 million families keep livestock including poultry in Ghana and it is estimated that about 12 million individuals rely on livestock for their livelihood (Ashley and Annor-Frempong, 2004). The industry is therefore a significant characteristic of Ghana's agriculture and contributes significantly to meeting food requirements, offering draught energy, soil fertility and structure and cash earnings. However, the extensive nature of the production systems and the high incidence of devastating endemic and trans-boundary animal diseases as well as arthropod ectoparasites infesting the animals ensure productivity remains low and the sector is unable to satisfy the growing needs of increasing populations for animal products (Angyireyiri *et al.*, 2015). Among the most serious variables affecting livestock production and productivity are diseases and parasites. Ectoparasite infestations have a major impact on husbandry, productivity and welfare of domestic animals (Colebrook Wall, 2004) and they pose a severe danger to livestock as well as humans throughout the globe. The biting behaviour of ectoparasites may directly cause increased levels of irritation, itching, and rubbing which in some cases results in self-wounding (Hussein, 1979; Wall, 2007; Kaufman *et al.*, 2009; Natala *et al.*, 2009).

Arthropod ectoparasites are a varied and extremely adapted group of animals that inhabit the external body surfaces of vertebrates. They may live on their host permanently, or they may occupy the nest and immediate environment of the host, and periodically visit the host's body for feeding. In either event, different life-sustaining resources are closely dependent on the host. The connection between parasite and host is an ancient one, and the processes by which parasites try, recognize and retain contact with their host is advanced and complicated.

Ectoparasites of insects and arachnids show a broad variety of types of connection with their hosts: obligatory to facultative, permanent to intermittent, superficial to subcutaneous.

Ectoparasites are organisms that for different periods inhabit the skin or outgrowth of the host's skin. The impact of ectoparasitic generally relies on the size of the invading population, how the parasite eats out of its life and the host animal's nutritional status when infected (Colebrook Wall, 2004). Ectoparasites cause mechanical wounds, but the situation is also complex by the response of the host to the presence, secretion and excretion of the particular parasite. Young animals are usually more vulnerable to ectoparasites due to the greater available surface-to-body volume ratio and bad disposal of faecal matter. Because it results in a broad spectrum of pathogenic impacts, the activity of ectoparasites infesting livestock and companion animal hosts is of specific concern. Feeding can cause skin and other subcutaneous tissues to suffer immediate harm, inflammation, and important blood loss.

Ticks alone transmit to livestock several significant protozoa, rickettsia, bacterial and viral diseases, resulting in major financial losses. In general, lice and mites cause dermatitis, associated by alopecia and necrotic foci. Intense pruritus (particularly with mange) is also present, which leads to biting and forceful scratching of impacted components.

## 1.2 Justification

Livestock farming is perennially plagued with infestation of ectoparasites. Livestock is affected by infestation of different arthropod ectoparasites, but little has been documented on their effects on their health and productivity in Ghana. Generally, there has been limited research work on the effects of arthropod ectoparasite infestations on livestock productivity in Ghana, without which proper and sustainable control methods will be difficult, if not impossible to achieve. However, studies have been conducted on effects of arthropod ectoparasite infestations on livestock productivity in three districts in Southern Ghana (Bah, 2016). Studies have also been conducted on the extensive nature of the production systems and the high incidence of devastating endemic and trans-boundary animal diseases as well as arthropod ectoparasites infesting the animals. They ensure productivity remains low and the sector is unable to satisfy the growing needs of increasing populations for animal products (Angyiereyiri *et al.*, 2015).

The knowledge gained on investigating the prevalence and effect of arthropod ectoparasites on livestock productivity could provide voucher specimen of the arthropod ectoparasites of livestock in Ghana, and also serve as a bench mark for the development of better control measures. Therefore, it is relevant to determine the prevalence rate of these ectoparasites and their effect on livestock productivity in the present study. This will provide well informed decisions to be taken on the most sustainable control measures against these ectoparasites. Ultimately, this will contribute toward increasing production and productivity in the livestock subsector. There is the need to assessing ectoparasitic infestation in rural and urban livestock production systems to ascertain the different ecological and biotic factors that promote or hinder the infestations of these ectoparasites under different environmental factors. The Greater Accra Region (a Coastal savanna) and the Eastern Region (Guinea savanna) of Ghana were chosen as study areas based on random

sampling of the ecological zones of Ghana as the distribution of arthropods is generally known to be influenced by environmental factors such as temperature of vegetation and because of convenience and accessibility.

### **1.3 Objectives**

#### **1.3.1 Main objective**

- To compare arthropod ectoparasitic infestations in rural and urban livestock (cattle, sheep and goats) production systems in the Greater Accra and Eastern Regions of Ghana.

#### **1.3.2 Specific objectives**

1. To determine the husbandry practices in urban and rural sites.
2. To determine the prevalence of arthropod ectoparasites on livestock in urban and rural sites.
3. To spatially map out the ectoparasite densities of the various study sites.

## CHAPTER TWO

### 2.0 LITERATURE REVIEW

#### 2.1 Livestock/Ruminant Production

Agriculture, which includes both crop and livestock production, remains the single biggest source of revenue and livelihoods for rural families in developing countries, generating more than 50% of household revenue in general. (Jayne *et al.*, 2003; Otte and Chilonda, 2003).

Ghana's livestock industry is a varied blend of small-scale and large-scale production technologies, with most rural communities relying on smallholder farms. Mixed farming with cash crops dominates farming priorities, but cattle (small ruminants, pigs and poultry) are becoming progressively crucial for many smallholder farmers (Peeling and Holden, 2004). ). The production of livestock takes place under three primary schemes. These are the systems that are intense, semi-intensive and comprehensive. The intensive system is performed primarily by commercial farmers, especially those involved in commercial poultry production, while the comprehensive system is usually practiced in rural societies where there is more land accessible (Adzitey, 2013). Semi-intensive system is suitable in areas with growing human population and developments that lead to land parceling. In the semi-intensive system, cattle graze in the field for some time during the day and in the evening they feed on supplements.

#### 2.2 Types of ruminants reared in Ghana

A significant and essential aspect of Ghana's agricultural economy is livestock production. (Diao, 2010), involving the rearing of both ruminant and non-ruminants, the former comprising of cattle, sheep and goats

and the latter comprises of pigs, poultry (domestic fowls, guinea fowls, turkeys and ducks), rabbits and grasscutters. (Adzitey, 2013).

### **2.3 Importance of ruminant production**

Livestock production is a very significant element of the developing countries' agricultural economy, a contribution that extends beyond direct food production to include multipurpose uses such as skin, fiber, fertilizer and fuel, and capital accumulation (Diao, 2010). In addition, livestock are strongly related to the social and cultural life of several million resource-poor farmers whose possession of animals guarantees differing degrees of sustainable agriculture and financial stability (Sansoucy, 1995). Livestock, particularly ruminant livestock is important to man and the environment. They are capable of converting vegetation from non-arable soil, crop residues, by-products from processing units and organic waste that would go unused into elevated nutrient density and dietary quality human foods that directly add to food safety (FAO, 2012). According to Ashley and Annor-Frempong (2004), over one and a half million households in Ghana keep cattle, including poultry, and about twelve million individuals rely on animals for their livelihood. It is estimated that the sub-sector contributes about 9 percent to the gross national industrial product (GDP) of the nation and is a source of revenue for several rural farm families, particularly in the southern portion of the nation.

Livestock is capable of providing food in the form of meat, milk and eggs which are significant livelihood benefits. The sector also compliments cropping activity through the provision of manure to improve crop yield, draught power for cultivation and transport of people and agricultural produce (Pender *et al.*, 2004). This adds another significant dimension to integrated crop-farming, which is the predominant manufacturing and subsistence system in most of the communal farming

systems to which the majority of rural livestock farmers in Ghana belong (Jayne et al., 2003; Otte and Chilonda, 2003). Within the household, livestock is capable of contributing to nutrition improvement, particularly for the most vulnerable in the society (women and children) (Vlassoff., 2007) in three ways:(i) by occasionally direct consumption of milk, eggs or meat; (ii) use of revenue from livestock sales and their products to purchase food and pay college charges when plants are not mature for harvesting; and (iii) increase crop output as a consequence of mixed farming (Tangka *et al*, 2000).

#### **2.4 Arthropod ectoparasites**

The name "Arthropoda" is Greek, meaning "jointed foot." Possession of joined appendages is the main distinguishing characteristic between arthropods and other phyla. A small fraction is parasitic to domestic animals but their harm is quite enormous (Thorp, 2009.) Arthropods comprise more than 80% of all known animal species and almost all known habitats (Yakhchali and Hosseine., 2006). They are covered by a hard chitinous exoskeleton divided by sutures into sclerites. Their segmented body and jointed apodemes (ingrowth or internal ridges of exoskeleton) allow movement (Thorp, 2009.).

Arthropod ectoparasites of veterinary importance can be grouped by intimacy of their association with their host. This association ranges from continuous ectoparasites to temporary ones that briefly once every few days contact the vertebrate (Mullens, 2009). Some are pests in their own right, while majority of them act as mechanical or biological transmitters for many pathogenic viruses, bacteria, protozoa and helminthes from one host to another including man, and serve as intermediate hosts of helminthes (Wall and Shearer., 2001). Arthropod ectoparasites can have

direct and indirect impacts on their hosts as a consequence of their activity. Including blood loss, myiasis, skin swelling and pruritus (itching), disturbance, toxicity and allergic response. Indirect effects are self-wounding, alopecia and as vectors of pathogens such as *Babesia* and *Anaplasma* (which have significant negative impact on livestock production (Wall, 2007)). Insects, mites and ticks are parasitic arthropods that have a important effect on their vertebrate animal hosts ' health, well-being and productivity (Walker, *et al.*, 2013).

## **2.5 Arthropod ectoparasite infestations on ruminant livestock**

According to Urquhart *et al*, 1996), there are two significant veterinary arthropod classes, Insecta and arachnida (Acarina mostly comprising of soft and hard ticks and mites) (Walker *et al.*, 2013). The four members of the insect orders considered as ectoparasites are: all members of the Phthiraptera (chewing and sucking lice), all members of the Siphonaptera (fleas), some members of the Hemiptera (real bugs) and the vast majority of free-living Dipteran species that are significant blood feeders as well as protozoan disease vectors. Additionally, there are several Dipteran insect taxa whose larval phases (maggots) feed on hosts ' living tissues causing different types of myiasis (Courtney and Keiper, 2009). These same arthropod organizations have an effect on livestock species, often causing considerable stress and changing feeding and motion behaviors. Although most mites are free-living predacious or plant-feeders, there is a small Sub-group that are parasites to animals. In contrast, all ticks are parasites, feeding primarily on blood of their hosts and acting as vectors for numerous serious pathogens (Jongejan and Uilenberg, 2004). Ectoparasite behavior can also cause indirect damage, such as direct nuisance impacts that lead to decreased time spent on grazing or ruminating and, in some instances, self-wounding due to scratching of itchy skin triggered by painful bites (Hussein, 1979). Ticks alone convey several major protozoans,

ricketts, bacterial and viral diseases to livestock and humans, resulting in major financial losses and negative impacts on human health. (Petney *et al*, 2007).

## **2.6 Phylum Insecta (Insects)**

Insects belong to the Arthropod of Phylum and the adult's body is split into three separate components: head, thorax and abdomen. They have one pair of sensory antennae, mandibular mouthparts and a pair of compound eyes on the head; and three pairs of legs and one pair or two pairs of wings on the chest (Chapman, *et al.*, 2013).

### **2.6.1 Order Diptera (flies)**

The *Diptera*, or "true flies" are, morphologically, biologically and ecologically, one of the biggest and most varied insect order. Diptera implies "two-winged," meaning they have a couple of wings. (Hall and Gerhardt, 2002). (Courtney and Keiper, 2009).

The Diptera have traditionally been split into two suborders: *Nematocera* ("lower" Diptera) and *Brachycera* ("higher" Diptera), sometimes further separated into *Orthorrhapha* and *Cyclorrhapha*. The dipteran insect head generally comprises of six fused segments with a single pair of antennae, mandibulate mouthparts comprising of a labrum, pair of mandibles, pair of maxillae, a hypopharynx and a labium. There is great variation in the adult mouthparts, depending on the feeding habits, with adaptation for slashing and sponging in brachycera, rasping and sponging or piercing and sucking in cyclorrhapha (Urquhart *et al.*, 1996). The pro-, meso- and meta-thorax each bears a pair of six jointed legs. The thorax of many insects also bears two pairs of wings, but in the Diptera, only one pair is functional, the other is reduced and known as halteres and has a balancing function. The abdomen is made of up to eleven segments with terminal modification

that carry the reproductive organs in insects, the sexes are distinct and the woman generates either eggs or larvae after fertilization (Courtney and Keiper, 2009).

Dipteran insect development is holometabolous as in fleas, where fertilized eggs hatch into larvae which undergo after three or more larval phases formation of pupae before the final adults emerge.

### **2.6.2 Order Phthiraptera**

Lice belongs to the Phthiraptera order. They are known to be wingless insects, strictly compulsory, mammalian and bird ectoparasites. Lice show high host specificities, spend their whole life on one host and cannot survive three to seven days away from their hosts. (Urquhart, *et al.*, 1996). Lice diet specializations underpin their significant taxonomic divisions that make it possible to separate them into those that feed on hair debris, fur and feathers and belong to the suborder Mallophaga, and those that belong to suborder Anoplura (sucking lice) which have specialized in blood feeding (Mullens, 2009). Although the number of lice species is not so much, heavy infestation of sucking lice can cause severe loss of blood resulting to anaemia particularly on young livestock. However, horses, cattle, sheep, goats and pigs may be heavily infested with sucking lice. *Haematopinus* and *Linognathus*, are key sucking lice of livestock (Urquhart *et al.*, 1996). Both sucking and biting lice can be a cause of irritation and skin harm that can result in manufacturing loss and hides and skin harm. Lice transmission happens mainly opportunistically when hosts are in close contact, especially during reproduction or under overcrowded circumstances (Faries, 2005).

Lice have a dorsoventrally flattened head and body. Lice are variable in size (0.4 - 30 mm in the adult stage), and colour (grayish white or tan to reddish brown). Most are blind, but a few species

have primitive eyes which are merely photosensitive spots (Chapman *et al.*,2013). Their antennae are capitate or beadlike with three to five segments. The Mallophaga have mandibles for chewing whereas the Anoplura have the mouthparts modified for piercing and sucking body fluid or blood. The legs terminate in claws, the lice of mammals having one large claw on each leg, while those of birds have two small claws on each leg.

Four species of lice feed on cattle; the most common is the little red chewing louse, *Bovicola bovis* which is recognized by its broad head and reddish brown coloration (Faries, 2005).. The remaining three lice are blood sucking lice namely the *Linognathus vituli*, the *Haematopinus eurysternus/quadrupertusus* and the *Solenopotes capillatus* and they can reach a maximum length of 30 millimetres (Geden *et al.*, 1989). The lice life cycle is hemimetabolous. On average the life cycle takes about 2 - 3 weeks depending on the environment and is composed of three stages (egg, nymph and adult). Adult louse lays eggs (nits) in their shells, eggs are cemented near the base of the hair and are easier to detect than the adult lice. During her lifetime of about 30 days, a female louse lays several eggs daily. In 1 to 2 weeks, the eggs hatch. Once the egg hatches, the nymphal louse, similar to a fairly small adult louse, experiences two extra moults before it becomes an adult(Walker, 2007).

### **2.6.3 Order Siphonaptera (fleas)**

Fleas are apterous insects and belong to the order *Siphonaptera*. They have mouthparts modified for piercing and sucking. Fleas are small blood sucking parasites attacking dogs, cats, and many other domestic animals (livestock, sheep, and goats), wild mammals, and birds (Lance *et al.*, 2002).

They can be discovered anywhere in the globe, whatever the weather. The flea populations indicate a seasonal pattern with peaks during the summer in areas with cold winters. Worldwide, more than 2,000 species have been defined. Fleas have higher affinity to sheep than in goat and have serious economic impact particularly on lambs due to their nuisance behaviour, and the high volume of blood they consume which may result to anaemia. Their control cannot be fully met by animal treatment alone (Fagbemi, 1982).

Fleas are small, light yellow to almost black wingless insects with laterally flattened body and short mouthparts modified for piercing and sucking, measuring between 1.0 to 8.5 mm in length (Chapman *et al.*, 2013; Hastriter and Whiting, 2009). They generally have varying number of bristles on body and short antenna with three segments lying in deep grooves on either side of the head which assist during mating (Chapman *et al.*, 2013). Their strongly sclerotized integument has a glossy surface and makes it quite simple to move through the hair and feathers. Fleas are not easily removed by preening or grooming due to the presence of backward pointing spines called combs or ctenidia found on the pronotal or/and genal borders, which are very important features in species identification (Lance *et al.*, 2002).. They generally avoid light by burrowing in animal hair or in dark crevices. Fleas are apterygota but have well developed hind legs for jumping and leaping which is mostly mistaken by many as flying. Both adult males and females are obligate haematophagous ectoparasites of mammals and birds. The females have an abdomen that points down unlike the male which has its abdomen pointing upward. Despite having host preferences, casual feeding is not uncommon and most will feed on a wide range of mammals and birds and are capable of causing dermatitis; transmitting plague (*Yersinia pestis*), murine typhus (*Rickettsia*) and tapeworms to human (Hastriter and Whiting, 2009).

Fleas breed close to the resting and sleeping places of their hosts, in dust, dirt, cracks in floors or walls, livestock pens and nest of birds. Development stages require high humidity. The life cycle of fleas is a holometabolous type, undergoing four stadia; egg, larva, pupa and adult. For the growth of eggs, females involve blood and keep laying eggs as long as they take blood meals. They lay eggs that have soft surfaces on the floor or host them to the floor. These eggs may hatch in two days or two weeks depending on the surrounding temperatures and humidity. The maggot-like larvae have a coat of bristles with chewing mouthparts and feeds on debris and faeces of the adult fleas which contain blood. They are four to ten millimetres long and though apodous, they are very mobile. They spin a cocoon (pupal stage), a form of wooly puparium, which is well camouflaged because it is sticky when newly spinned and soon becomes covered with dust, sand and other fine particles. As pre-emerging adults, the flea pupae can stay in bedding without hatching for up to 6 months. Such fleas detect their body heat, movements, footprint pressure, and enhanced breathing carbon dioxide that stimulates their development once animals come close. The ambient temperature depends on both moulting and pupation. The life cycle can be completed in warm conditions in three weeks, while it can be extended in low temperatures for two years. Fleas spend most of their life cycle away from the host, not only the eggs, larvae and pupae, but also the adults who can spend up to six months between feeds. One to two years is the usual life span of fleas (Lance et al., 2002).

#### **2.6.4 Order Arachnida**

Unlike insects, instead of head, thorax and abdomen, the arachnid body is ancestrally divided into the prosoma or cephalothorax (the first fused six body segments) and the opisthosoma or abdomen

(the remaining body segments) (Thorp, 2009). The Arachnida include ticks, mites, spiders and scorpions, but those of considerable veterinary importance are the ticks and mites. The adult has four pairs of legs on the idiosoma. There are no antennae, and the chelicerate mouthpart is greatly modified and carry hypostome in the middle, a pair of inner chelicerae and a pair of outer palps on both sides of the chelicerae. These structures are borne on the basis capituli or false head (Walker *et al.*, 2013). The legs are joined seven times and articulate through the coxae with the body. The existence of only three pairs of legs makes it easy to recognize larvae, while nymphs and adults have four pairs of legs. The lack of genital aperture distinguishes nymphs from adults.. The pulvillus and a pair of claws found on each tarsus of most species is absent in argasid nymphs and adults. An organ called Haller's organ is found on the dorsal surface of the tarsus of leg I in all stages of ticks. It consists of an anterior pit and a posterior capsule containing an odor-detecting sensory apparatus. Functions like gustatory, thermosensory and mechanosensory have been associated with this Haller's organ. It is also used for distinguishing genera and species (Sonenshine *et al.*, 2006).

### **2.6.5 Ticks**

Ticks are from two families, the first family is Ixodidae often referred to as hard ticks due to the existence of a rigid chitinous scutum covering the adult male's entire dorsal surface, but covering only a tiny region behind the head of the adult woman and nymph stage. All year round these ticks are discovered (Yakhchali and Hosseine, 2006). The second is the soft ticks of the Argasidae.

### **2.6.5.1 Global distribution of tick vectors**

Worldwide, there are roughly over 900 recognized tick species (Estrada-Pena *et al.*, 2015). Of all the species, approximately 700 species are Ixodid or hard ticks and 200 species are Argasid or soft ticks. In Africa, about 200 Ixodid and 40 Argasid species have been documented (Madder *et al.*, 2001). Most of the tick species known to be of veterinary and medical importance belong to just three genera, *Amblyomma*, *Hyalomma*, and *Rhipicephalus* (Fournier and Raoult, 2004; Rajput, *et al.*, 2006). Across the continent, ticks of the three implicated genera cause harm that is either mechanical (skin injuries and irritations) or are involved in biological transmission of pathogens to both animals and humans (Brites-Neto *et al.*, 2015). A significant number of the tick infestations and tick-borne infections are usually prevalent in specific geographic regions. However, with globalization and environmental change, their range might grow and even spread intercontinentally (Carletti *et al.*, 2010). In Ghana, a number of ticks have been identified belonging to the genera *Amblyomma*, *Hyalomma*, and *Rhipicephalus* (Akuffo *et al.*, 2016; Kobayashi *et al.*, 2017).

### **2.6.5.2 Brief description of ticks**

Within smallholder dairy, crop-livestock and livestock-dependent schemes, livestock contribute to natural, economic, human, physical and social capital in various respects and degrees (Sansoucy *et al.*, 2015). According to Mandell (2000), ticks are second only to mosquitoes as human disease vectors. They are also one of the major threats in the tropics to the livestock industry. They may impact the health of livestock, thus affecting output and productivity.

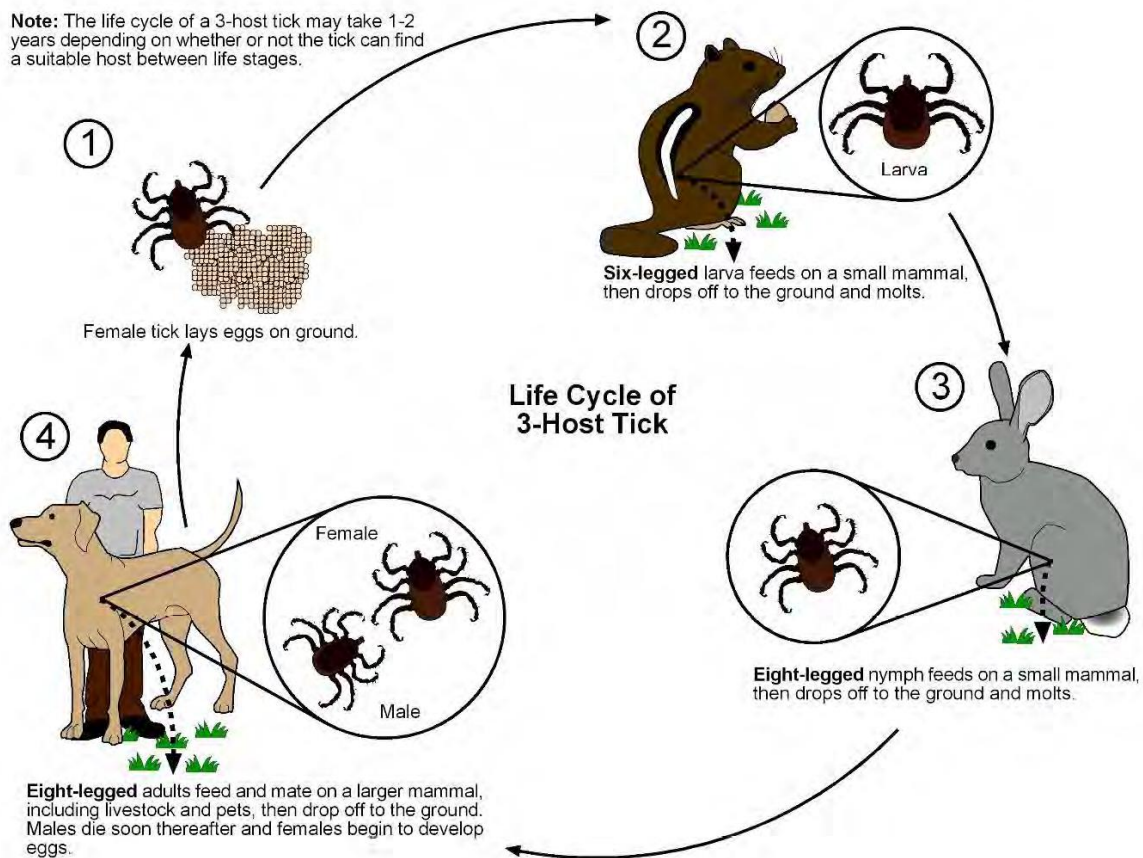
The mouthparts of ticks are borne on the basis capituli which have different shape structures depending on the species. Mouthparts consist of a median hypostome, a pair chelicerae lateral to hypostome with mobile digits adapted for cutting, and a pair of sensory palps lateral to the chelicerae. The hypostome has recurved teeth for maintaining anchorage and position on host and are very significant for species identification. It also bears a dorsal groove to permit the flow of saliva and blood during feeding. The mouthparts borne on the capitulum are anterior and visible when viewed from the dorsal surface for Ixodidae unlike Argasidae that have the ventrally placed mouthparts that cannot be seen from above. There are series of grooves on the scutum and body and row of notches called festoons on the body's posterior boundary, and chitinous plates on the male's ventral surface all serving as distinguishing characteristics. The genital opening with the posterior anus is discovered in the ventral midline. Some ticks are ornates with enamel-like areas on their body. The adults have a pair of spiracle behind the fourth pair of coxae. Some coxae have spurs depending on the tick species. Eyes are situated on the outside margin of the scutum when present (Urquhart *et al.*, 1996). Argasidae are flattened and covered by small marginal discs and their eyes occur on folds lateral to coxae of legs when present (Sonenshine *et al.*, 2006).

### **2.6.5.3 Life cycle of ticks**

Majority of hard ticks require three hosts to complete their life cycle and during this development they go through four stages. These stages are egg, larva (also called seed tick); nymph and adult without a pupa, hence are hemimetabolous (Table 2.1). Adult ticks mate after feeding. The gravid female drops from the host and lay thousands of eggs on the ground (Walker, 1996). The eggs hatch into larvae or seed ticks which quest for a host. After feeding they leave the host and moult

to nymphs, which also look for a host to feed after which they moult to adults. The adults feed, mate and the cycle is repeated.

Argasids take several small blood meals and lay small batches of eggs unlike ixodids that take large blood meal once and lays more eggs and die. Most argasids have two or more nymphal instars in their life cycle, each of which mostly consume blood and moulting occurs.



**Figure 2.1** Life Cycle of Ticks (Adapted from Charlesworth, 2008a)

#### **2.6.5.4 Feeding behaviour of ticks**

The Ixodids are obligate haematophages known to be important vectors of protozoan, bacterial, viral and rickettsial diseases which have direct bearing on the health of animals and humans (Wall *et al.*, 2001). The argasids spend relatively short time on their hosts to feed, hence are temporal parasites, despite being obligate parasites. They are either one-host, two-host, three host or multiple ticks depending on the number of animals they get attached to during their life cycle, hence their greater ability to transmit disease causing agents to livestock. Because ticks are obligate haematophagous and feed on different hosts, they are good vectors capable of transmitting disease-causing agents from one animal to the other (Knipling and Steelman, 2000). Hard ticks feed in each active stage (larval, nymph and adult) ingesting substantial quantities of blood. For each active stage of ticks, different hosts may be fed on. The larvae and nymphs will usually feed on small hosts like rodents, while adults usually feed on large animals such as cattle. However, some tick species are highly host-specific. This means the absence of such specific host(s) in a habitat may prevent the infestation of those ticks that specifically feed on them. When ticks climb onto a suitable host, they search for a favourable spot for feeding. After probing the skin and finding a favourable site of attachment, the tick inserts its mouthparts to begin feeding. During feeding, ticks are known to secrete tick saliva that act as an anesthesia to disguise the pain from the bite and hinder blood from coagulating. Due to the efficient feeding behaviour of ticks and their firm hold on the host once attached, they have the potential for transmitting diseases.

(Estrada-Peña, 2015).

#### **2.6.5.5 Host Seeking Behaviour of Ticks**

Ticks are capable of detecting a suitable host by sensing body scent, temperature and vibrations. (Sonenshine et al., 2006). Some species of ticks exhibit a behaviour known as questing. This involves selecting a vegetation a well-used path by hosts and waiting by being positioned on the tips of grasses and shrubs. Questing ticks usually have their first pair of legs extended in anticipation of the host in order to successfully climb on. Once a host is in close proximity, the questing tick will grasp and climb onto the host to commence feeding (Centers for Disease Control and Prevention, CDC., 2013). While some ticks prefer to attach quickly at the site of contact with the host, others move to places on the host with thinner skin (Estrada-Peña, 2015).

When ticks attach to the host, they cause irritation of the skin with subsequent ulceration, and sometimes secondary bacterial infections may result (Parola *et al.*, 2001). Wounds caused by ticks may become infested by screw-worms or other agents of myiasis, and are also associated with the spread of bovine dermatophilosis caused by *Dermatophilus congolensis* (Koney *et al.*, 1993). All of these decrease production and damages skin and hides. Heavy infestations of ticks can result in anaemia, particularly in small and older animals, and the restlessness caused by the presence of large numbers of ticks can lead to a significant loss of weight and condition (Pegram and Osterwijk, 1990). *Amblyomma*, *Ixodes*, *Hyalomma* and *Rhipicephalus* are genera recognized for such direct and indirect effects. Some ticks are capable of causing toxicosis to livestock which causes progressive, ascending, afebrile paralysis, which can be relieved by quickly removing the tick, if not removed animal can die of it.

#### **2.6.5.6 Identification of Ticks**

Tick species are morphologically identified using microscopy appropriate taxonomic keys unique to the geographic regions (Hubálek and Rudolf, 2012; Walker *et al.*, 2003). However, this method can be strenuous as it requires some entomological expertise and the damaged specimen will be difficult to identify (Hubálek and Rudolf, 2012). Molecular methods including mitochondrial cytochrome oxidase subunit 1 (COX1) and nuclear internal transcribed spacer 2 (ITS2), have been developed to identify arthropods such as ticks (Song *et al.*, 2011). The MALDITOF Mass Spectrometry has also been employed in the rapid identification of tick vectors (Yssouf *et al.*, 2013).

#### **2.6.6 Some tick-borne diseases**

The most damaging effect of ticks is their ability to transmit diseases, some of which can be fatal to the livestock. According to Kaufman *et al.* (2009), the tick-borne diseases of importance to the livestock industry can be classified as follows:

##### **2.6.6.1 Anaplasmosis**

This group of diseases is caused by rickettsia-like organisms of the genus *Anaplasma*, which are usually transmitted by ticks, but which may also be transmitted mechanically by biting Diptera (e.g. Tabanidae and *Stomoxys*). Anaplasmosis affects domestic and wild ungulates and is widespread throughout the tropics.

### 2.6.6.2 Rickettsial Infections

The genus *Rickettsia* was classically classified into the typhus group (TGR) and spotted fever group (SFGR). It has however been further subdivided based on phylogenetic analysis with the scrub typhus group composed of *Orientia* spp. (formerly of the genus *Rickettsia*). Rickettsial infections are mostly transmitted by ticks during feeding or by scratching content of crushed ticks into the skin. Numerous human-pathogenic tick-borne *Rickettsia* species have been found in the West African subregion including Burkina Faso and the Ivory Coast, with human seroprevalence rates ranging from 17 to 36% (Mediannikov *et al.*, 2010). In travellers, including military personnel, the most frequently diagnosed rickettsial diseases are the murine typhus or spotted fever (African tick-bite fever) but travellers may acquire a wide range of rickettsioses, including emerging and re-emerging species (Leshem *et al.*, 2011). American soldiers participating in a 10-day training exercise in Botswana had an attack rate of approximately 30 % for African tick-bite fever (Smoak *et al.*, 1996). In 2009, a study conducted in Nigeria reported infection rates of unfed ticks to be 3.1 % for *Rickettsia* species, 0.1 % for *Coxiella burnetii* and 0.4 % for *Borrelia* species; for feeding ticks collected from cattle, the infection rates were .12.5 % for *Rickettsia* species and 14 % for *Coxiella burnetii* (Reye *et al.*, 2012). Amongst the tick-borne spotted fever *Rickettsia* species found within Africa, the two most common are *R. africae* and *R. aeschlimannii*. The African tick bite fever is caused by *R. africae*. *Amblyomma hebraeum*, also known as the bont tick in Southern Africa is the focal reservoir and vector of *R. africae*, whereas *Amblyomma variegatum*, a widely distributed vector, is responsible for transmitting the bacteria in West, Central, and East Africa. The first tick infection by *R. aeschlimannii* was detected in *Hyalomma marginatum* in Morocco in 1997 and continues to spread across the continent (Beati *et al.*, 1997). In recent times, *R. aeschlimannii* has been identified in Northern and North-Eastern countries of African. An

example is the detection of the bacteria in *Hyalomma aegyptium* and *Rhipicephalus bursa* among tick samples collected from humans in Turkey (Gargili *et al.*, 2012).

### **2.6.6.3 Heartwater**

It is an infectious, non-contagious, disease of domestic and wild ruminants (Walker and Koney, 1999). This disease also called cowdriosis is caused by the rickettsial organism *Ehrlichia* (formerly *Cowdria*) *ruminantium*. The disease is transmitted by *Amblyomma variegatum* which is the widespread vector most prevalent in the Caribbean and all over Sub-Saharan Africa except certain areas of Southern Africa (Uilenberg, 1983). It is specific to ruminants (cattle, sheep, goats and some wild ruminants). Heartwater or cowdriosis is most severe in small ruminants, but also causes heavy losses in exotic cattle, which are more susceptible than indigenous breeds. However, indigenous cattle can also be affected if poor conditions weaken their immune system, or if animals are moved from an area free of heartwater to an area in which it is endemic (Wikel, 1999).

### **2.6.6.4 Babesiosis**

*Babesia* spp are protozoans distributed around the world and usually infect the blood cells of many vertebrates (Telford *et al.*, 1993), inducing the disease babesiosis.

In dogs, four *Babesia* species including *Babesia canis*, *Babesia vogeli*, *Babesia gibsoni* and *Babesia vulpes* cause infections (Baneth *et al.*, 2015; Matijako, 2012). Factors that influence the gravity of the disease, as well as clinical signs, include the specific *Babesia* species infection and the immunity of the host animal (Solano-Gallego and Baneth, 2011). Humans have been found to become susceptible to babesiosis in situations where they are otherwise immunocompromised with the common causal agents being *Babesia divergens*, a parasite of cattle, or *B. microti*, found in

rodents (Gray *et al.*, 2010). In the process of blood feeding on an infected host, ticks acquire *Babesia* spp., even though the transovarial transmission of *B. canis* has been detected through up to five tick generations (Chauvin *et al.*, 2009). In the tropics and sub-tropics, Babesiosis is an economically important tick-borne protozoan disease which affects cattle (Bhat *et al.*, 2017). The genus of *Babesia* known to cause infection in cattle includes *B. bovis* and *B. bigemina*, which is responsible for most infections and. These are transmitted by cattle fever tick, *Rhipicephalus microplus* (Murrell *et al.*, 2001). In Ghana, a study conducted to determine the sera-prevalence of tick pathogens across the country's three ecological zones showed the prevalence rate of *B. bigemina* was 2 % for a sample size of 397 cattle (Beckley *et al.*, 2016). To identify *Babesia* parasites in an individual, a peripheral blood smear is prepared and stained with Giemsa.

However, when the level of parasitaemia is too low, latent infections are likely not to be detected. Other methods employed involve detecting antibodies against *Babesia* infection in cattle using Indirect fluorescent antibody test (IFAT) and the enzyme-linked immunosorbent assay (ELISA) (Bhat *et al.*, 2017). Recently, in the study of the epidemiology of babesiosis, PCR-based assays which are sensitive and specific have been used to detect infections in both vertebrates and tick species. (Tavassoli *et al.*, 2013). Drugs such as imidocarb or diminazene aceturate have been used in the treatment of babesiosis. New pharmacological compounds are being developed and evaluated, offering new alternatives to control the disease (Mosqueda *et al.*, 2012).

#### **2.6.6.5 Tick-borne Encephalitis (TBE)**

Tick-borne encephalitis (TBE), is a significant viral infection of the central nervous system affecting humans and animals in Europe and many locations in Asia (Hubalek *et al.*, 2012). The tick-borne encephalitis virus (TBEV) is estimated to cause infections in about 11,000 human cases

annually, mostly in Russia (Gritsun *et al.*, 2003). Even though there are vaccines to prevent TBE infections, the incident rates continue to rise causing a major public health concern in almost all endemic European and Asian countries. Countries outside endemic regions are at risk of exposure due to an increase in tourism (Süss, 2011). The main reservoirs and hosts of TBEV are small rodents with humans serving only as accidental hosts. The virus is spread to humans primarily through the bites of hard ticks (Bogovic *et al.*, 2015). There is currently no specific antiviral treatment for TBE. Patients may be hospitalized and supportive care given depending on the severity of the infection. Preventive measures to avoid becoming infected with the virus include the pasteurization of milk, limiting the tick population and the use of personal protective procedures and equipment. The best way to avoid infection is active immunization. The disease is zoonotic in nature with no chance of human to human transmission. This means that vaccination is for individual protection and not the entire population.

#### **2.6.6.6 Theileriosis**

This disease is caused by species of the protozoan *Theileria*, transmitted by ticks of the genera *Rhipicephalus*, *Hyalomma* and *Amblyomma*. *Amblyomma* is one of the ticks known to be present throughout the year due its ability to thrive in different climatic and weather conditions (Natala *et al.*, 2009). *Theileria* is responsible for the most pathogenic tick-borne diseases of cattle. Theileriosis represents one of the most important threats to livestock production in the tropics; mortality levels may reach 90 % in endemic situations and in susceptible animals, hence it is a major constraint on the livelihoods of millions of rural farmers (Mukhebi, 1992).

#### 2.6.6.7 Lyme disease

Lyme disease caused by the bacterium *Borrelia burgdorferi*, and **Relapsing fever** also caused by *Borrelia spp.* The former is transferred by the *Ixodes* genus ' comparatively slow-fed (difficult) ticks and the latter by the genus ' fast-fed argasid (smooth) ticks *Ornithodoros*. Relapsing fever is also transmitted through the bite of human body louse (*Pediculus humanus humanus* (Schwan and Piesman, 2002).

#### 2.6.6.8 The Control of Ticks and Tick-borne Diseases

There has been a wide range of prevention and control methods to decrease tick infestation, the incidence of tick-borne pathogens and the risk of human vulnerability to tick-borne pathogens (Eisen *et al.*, 2016). These measures are usually split into personal protection strategies such as the use of repellents, protective clothing and tick removal procedures. These are aimed at decreasing tick-to-human contact, decreasing tick infestations or decreasing tick-borne pathogens in ticks. Some techniques include acaricides and use of biological control agents in tick vector control (Stafford *et al.*, 2017).

Over the past decades, the application of acaricides has become the main technique for controlling tick infestation on domestic animals as well as in the environment. Semiochemicals (pheromone, kairomones, and attractants) may be utilized to improve acaricide potency or reduce pesticide concentrations (Sonenshine *et al.*, 2006). The use of acaricides has however caused the contamination of the environment, milk and meat products and the development of acaricide-resistance in ticks. Globally, there are vaccines aimed at controlling tick-borne infections. There is also a need to create anti-tick vaccines that are suitable for a more global protection against the main species of economic and epidemiological interest (Domingos *et al.*, 2013).

## **2.7 Factors influencing arthropod ectoparasite infestations in livestock**

The arthropod ectoparasites discussed above are influenced by various challenges and factors that may affect their survival, reproduction and spread from one host to another. Rainfall, temperature, vegetation, competing species and management/husbandry practices are key environmental factors that influence arthropod infestation in livestock. Husbandry practices where livestock from different communities are grazed together have a key influence in general on the spread of arthropod ectoparasites (Asmaa *et al.*, 2014). Ideal temperature and availability of moisture are key factors for the life cycles of most arthropod ectoparasites (DeClercq *et al.*, 2013), as they regulate development and the mortality rates of the complete life cycle during the time spent away from the host (off-host). Temperature has potential influence during moulting periods (Sonenshine *et al.*, 2006), a process which arthropods undergo to allow increase in size. All found that when there is increase in moisture and decrease in temperature, arthropod ectoparasite (ticks, lice and fleas) infestations also increase. According to Asmaa *et al.* (2014), breed, age and sex are key host factors that influence tick infestation in livestock. The tick prevalence is higher in indigenous cattle breed than crossbred and infestation is higher during summer when temperature has high influence on tick population (Kabir *et al.*, 2011). Tick infestation is highest in cattle, followed by sheep and then goats in terms of species with the udder and genitalia as the most ideal predilection sites.

These parasites do not only parasitize livestock but also humans particularly, those who work in close contact with infested livestock (Angyiereyiri *et al.*, 2015), hence the importance of having information on their prevalence and an estimate of the economic losses caused by these parasites. Therefore, this research evaluated the impacts of infestation of arthropod ectoparasites on livestock productivity in order to generate a dataset that could assist formulate approaches for controlling ectoparasites in the regions and its surroundings.

## **CHAPTER THREE**

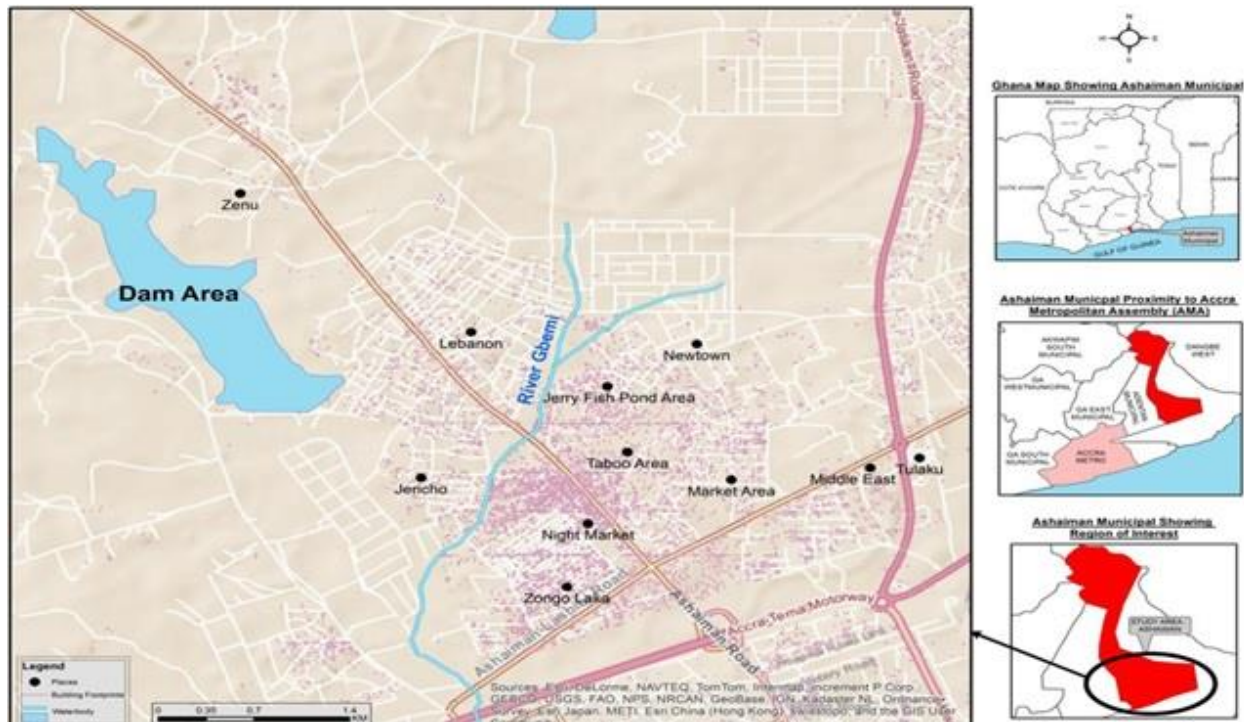
### **3.0 MATERIALS AND METHODS**

#### **3.1 Study Area**

A cross-sectional study was done in both rural and urban areas. Two sites in the urban areas as well as two sites in the rural areas were randomly selected for sampling. The Greater Accra Region in the Coastal Savannah ecological zone and Eastern Region in the Semi Deciduous Rain Forest were the main regions where the study was carried out. The Ashaiman District and the Livestock and Poultry Research Centre (LIPREC) also called the University Farm were the sampling sites for the urban areas. Somanya and Akuse were the sampling sites for the rural areas.

##### **3.1.1 Selection and Description of Study Sites**

The study sites were selected based on simple random sampling methods and as a matter of convenience. Ticks samples were collected from cattle from within two ecological zones of Ghana – the Coastal Savanna and the moist semi-deciduous rainforest ecological zones, as the distribution of arthropods is generally known to be influenced by environmental factors such as temperature and vegetation. The tick samples were collected from Ashaiman and the University Farms from the urban sites in the Greater Accra Region and Somanya and Akuse in the rural areas respectively.



**Figure 3.1:** A map of Ashaiman showing the study sites in the urban area

### 3.1.2 Ashaiman

The Ashaiman District ( $5^{\circ} 41' 59.99''$  N  $0^{\circ} 01' 60.00''$  E) is in the Greater Accra Region of Ghana (Figure 3.1). It has over 200 livestock farmers and a large kraal containing various breeds of cattle at the centre of the district at a place known as Jericho (Google, 2017). The kraal houses about 250 cattle. Ashaiman also has a large market noted for trading in cattle and other smaller livestock from people all around Africa and beyond at a place known as Tulaku market. Its average humidity is 90 % and an average temperature of 25 °C.



**Figure 3.2:** A map showing the study sites in the rural Akuse area (Google 2017)

### 3.1.3 University Farms (LIPREC)

The University Farms at Livestock and Poultry Research Centre (LIPREC) ( $5.6731^{\circ}$  N,  $0.1664^{\circ}$  E) is a centre for livestock and poultry production. It has vast land that is used for research purposes with regards to poultry production. The kraals are able to hold 150 cattle at a time and 300 goats and sheep are separately penned and kept for research. Pigs are also kept for research purposes. Its average annual humidity is 90 % and an annual average temperature of  $25^{\circ}$  C.

#### **3.1.4 Kpong (Belekope)**

Kpong (6.182029° N, 0.073071 °E) is located in a typical savannah vegetation that is located in the Eastern Region of Ghana in the Lower Manya Krobo District (Google, 2017). The Kpong areas have several kraals and a large unroofed enclosure that houses about 150 cattle and has no crush pen. Other small livestock farmers are also found in the area. Its average annual humidity is 78 % and an annual average temperature of 28 °C.

#### **3.1.5 Akuse (Okwenya)**

Akuse (6.089404° N, 0.033857 °E) is another site in a typical savannah vegetation in the Eastern Region. It is also found in the Lower Manya District . The Akuse areas have several kraals under a large unroofed enclosure that houses about 250 cattle but has no crush pen. Other small livestock farmers are also found in the area. Its average annual humidity is 78% and an average temperature of 28 °C annually.

#### **3.1.6 Teye Kwame (Somanya)**

Somanya (6.054095 ° N, 0.0282° E) has a shrubland vegetation and a vast amount of land with several kraals and farms that are used for livestock production. Its average annual humidity ranges between 92 % and 94 % and an average temperature range of 25.9 °C - 41.6 °C annually.

#### **3.1.7 Agormeda (Somanya)**

Agormeda (6.054095 ° N, 0.0212° E) has a shrubland vegetation and a vast amount of land mostly used for livestock production. It has several kraals and farms and its average annual humidity ranges between 92 % and 94 % with an average temperature range of 23.9 °C - 30.9 °C annually.

### **3.2 Sampling procedure and Questionnaire administration**

Twenty (20) households were purposely sampled because of their willingness to participate in the study both by accepting to respond to the questions in the questionnaire, and assisting in the parasitological work by restraining the animals for the collection of arthropod ectoparasites from the livestock. Questionnaires with 42 closed-ended and one open-ended questions were written in English and administered to individual farmers to assess their knowledge on arthropod infestation on livestock, their husbandry practices, and their expenditure and gains from the livestock. More information on the types of pesticides, methods of application/administration, knowledge on dilution, and their storage were gathered through further discussion and interactions. Keen observation notes of the livestock kraals (Fig.3.3), pen types, watering and feeding practices were taken throughout the study. Farmers were also questioned during and after sampling about their relationships with other livestock owners and crop farmers.

### **3.3 Tick Sample Collection**

The study did not involve experimentation procedures on the cattle. At each sample collection visit, ticks were directly removed from as many conveniently sampled cattle. The body of the cattle

was divided into seven regions, the head, dewlap, back, udder/scrotum, limbs, anal and tail regions.

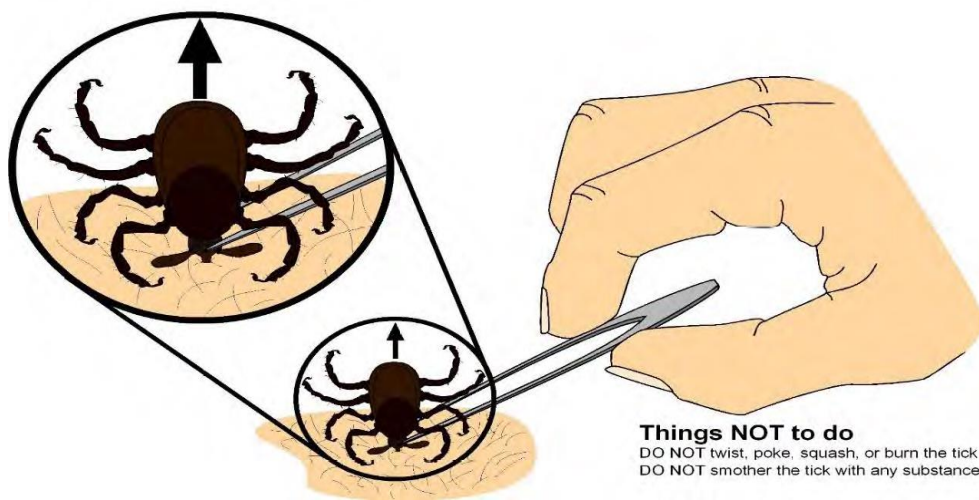


**Figure 3.3:** A kraal of cattle in a rural site

The sampling process involved a physical examination of the cattle and collection of ticks off the animals with the assistance of cattle handlers who had undergone training on tick removal and sample labelling (Fig.3.4). The blunt forceps were used to find and hold the mouthparts of the ticks, then applying a gentle tug the ticks were pulled away from the animal till they detached (Fig 3.5). The ticks were grouped and stored in different sample vials.



**Figure 3.4:** A cattle being restrained for tick sampling



**Figure 3.5:** Procedure for picking of a tick using blunt forceps  
Source: (Charlesworth, 2008b)

### **3.4 Lice and fleas collection**

Clinical examination for lice and fleas was done by multiple hair partings and the parasites were collected using forceps. For fleas, either water or ethanol was applied on the animal coat to immobilize fleas before removal. Animal coat and hooves were examined for other parasites such as myiatic larvae, while areas with crusts or lesions suspected to be mange were deep scraped with oil, smeared scalpel blade (Hendrix, 1998) as cited in Yakhchali and Husseine (2006)

### **3.5 Preservation of parasitic arthropods**

In individual 1.5 ml Eppendorf tubes containing 70 % ethanol, collected ticks, lice and fleas were placed. Skin scrapings comprising 5 % formalin were also placed in 1.5 ml Eppendorf tubes. All the tubes have been labeled properly. Both samples and field recorded data were transported to the Parasitology Laboratory of the Department of Animal Biology and Conservation Sciences for further processing and analyses.



**Figure 3.6:** Eppendorf tubes containing collected arthropod ectoparasites next to a dissecting microscope.

### **3.6 Morphological identification of collected arthropod parasites**

Lice, ticks and fleas were directly examined under Leica EZ4 HD® dissecting (8X - 40X) and Leica icc50 HD® compound microscopes (10X and 40X) to morphologically identify the specimens.

#### **3.6.1 Tick Identification**

Tick identification was carried out in the Parasitology Department of the Animal Biology and Conservation Science (DABCS) using a dissecting microscope at 4x-10x magnification and “Ticks

of Domestic Animals in Africa: a Guide to Identification of Species” as the reference key for morphological identification of the different genera and species (Walker *et al.*, 2013). Hard ticks were identified by the presence of a scutum or shield on the dorsal side and by having their mouthparts that can be seen from above. In males, the scutum extends across most of the dorsal side, while in the females, it usually covers between a third to half of the dorsal area. Other basic characteristics in the identification of hard ticks at the level of the genus include the length of the mouthpiece, the presence or lack of eyes, the presence or lack of festoons, color or markings on the scutum, and the shape and placement of the anal groove (Mathison and Pritt, 2014).

Following identification, the ticks were grouped into pools of two or three by species, sex, and point of collection on cattle and stored in eppendorf tubes in 100% alcohol for further molecular studies.

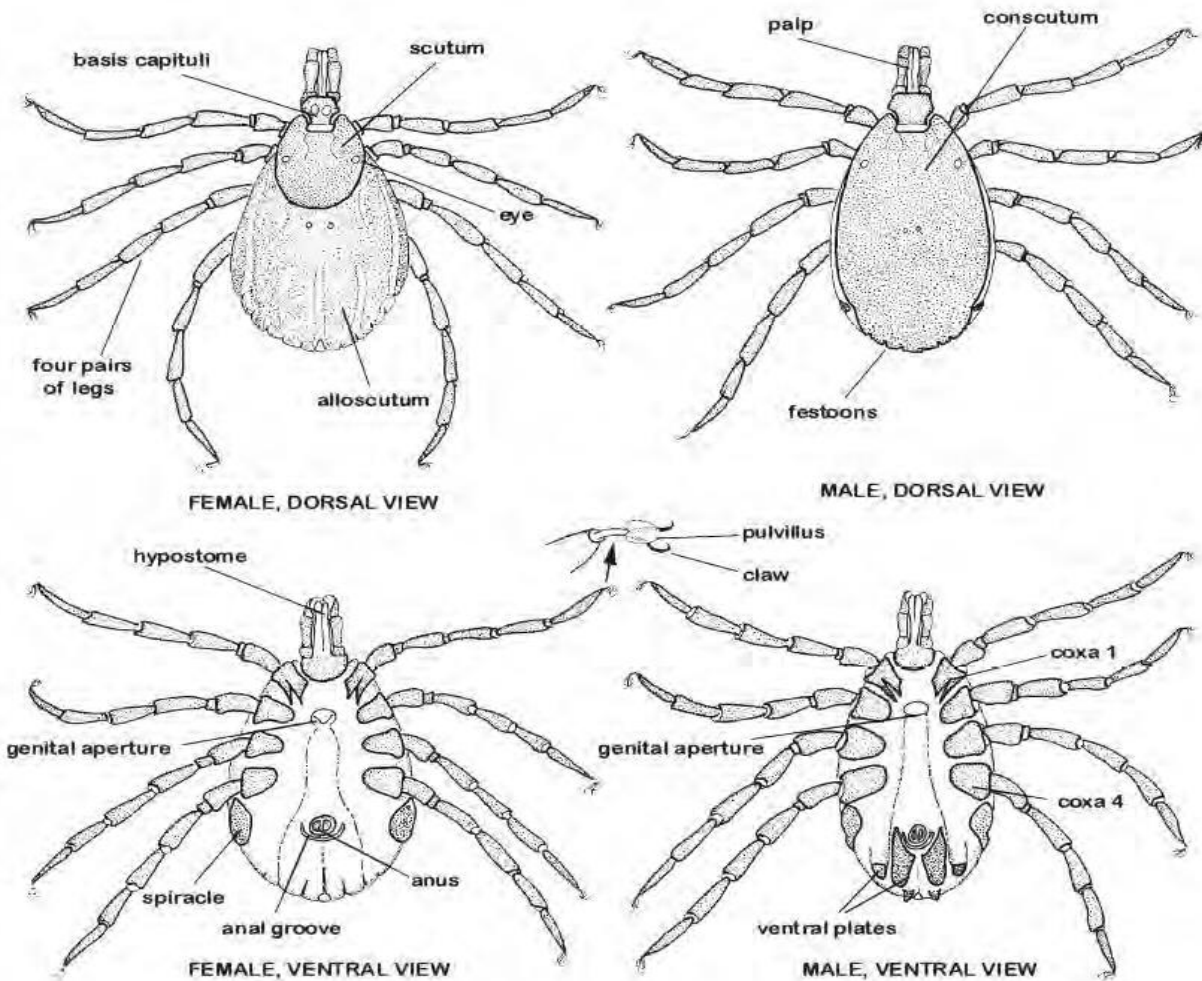


Figure 3.7: External structure of adult ixodid ticks. (*Hyalomma* spp.) (Walker *et al.*, 2003)

### 3.6.2 Identification of lice

Presence or absence of eyes, length and width of thoracic sternal plates when present, shape (blunt rounded or acute and long) of thoracic sternal plates with median projections, sternal pits on or off plate, head length at ocular points compared to its width, length of antennae compared to length of head at ocular points, shape of head behind the antennae expanded or and shape of fore head (rounded or acutely conical) were used for lice (Mathison and Pritt., 2014).

### **3.6.3 Identification of fleas**

Morphological features like presence or absence of genal and or pronotal combs, number of spines of genal comb and presence or absence of eyes; orientation (vertical or oblique) of genal comb; shape (blunt or pointed) of spines of body combs, ratio of head length to height; and difference in length of spines I and II of the genal comb were used for fleas (Mathison and Pritt., 2014).

## **3.7 Data processing and analysis**

### **3.7.1 Data processing**

Data on morphological identification, Global Positioning System (GPS) coordinates, site of attachment were recorded and collated in Microsoft Excel 2013.

All data (both questionnaire and sampling scoring format) were entered in SPSS version 20. Data from sampling scoring format were also entered in Excel spread sheet. Questionnaires were analysed using descriptive statistics.

Assessment of farmers awareness of arthropod ectoparasites, farmers perception on effects of arthropod ectoparasite infestations on ruminant livestock productivity, determination of the relationship between husbandry practices and prevalence of arthropod ectoparasite infestations on livestock and effects of arthropod ectoparasite infestation on livestock output were done using descriptive statistics. Independent or unpaired T-test was used to compare ectoparasitic infestation in rural and urban sites.

### **3.7.2 Geographic information system analysis**

The data on the distribution and abundance of tick species collected in the six study sites were captured, stored, manipulated and analyzed with the GPS coordinates. The coordinates of the corresponding study sites was used in spatial analysis to display the information in a map or graphical form.

### **3.7.3 Study Challenges**

Most of the kraals at the study sites did not have crush pens so the animal handlers had to immobilize the cattle by roping them down for sampling arthropod ectoparasites. This made sampling procedure quiet cumbersome. Efforts were made to minimize discomfort to the cattle and ensure the safety of the animal handlers and research assistants. Built-in crush pens that restrict movement in the cattle would have made the sampling process less cumbersome. The same built in crush pens applied to the small ruminants (goats and sheep).

## CHAPTER FOUR

### 4.0 RESULTS

#### 4.1 Livestock structure

In total twenty (20) farmers were interviewed. Ten (10) out of the 20 were from the urban sites, while 10 were from the rural sites.

A total of 25 kraals of cattle and 28 flocks of small livestock (20 flocks with sheep only, 6 flocks with goat only and 2 flocks with both sheep and goat) were considered in the study. Out of the 25 kraals of cattle, 74 % of them had between 50 to 100 cattle and 26 % had between 100 and 500 cattle. Sixteen (16) out of the 25 kraals and 10 of the flocks were sited in the rural areas. 18 of the flocks and 9 kraals of cattle were located in the urban areas. (Table 4.1)

**Table 4.1: Farmers Interviewed and their Livestock Structure**

Site	No of farmers	Kraals of cattle	Flocks of small livestock
Urban sites	10	9	18
Rural sites	10	16	10
<b>Total</b>	<b>20</b>	<b>25</b>	<b>28</b>

Four (4) of the respondents had between 100 to 500 cattle, but were divided into two kraals for easy management. Three of the sampled pens kept both cattle and small ruminants. About seventy percent (70 %) of the 20 sheep pens sampled had less than twenty sheep. Three of the six sampled goat pens had between 10 and 50 goats, and one of the two sampled sheep and goat mixed pen had more than 10 ruminants.

The dominant cattle breeds were Sanga, Gudali, Ndama and Zebu. The dominant sheep breed was the Nungua black head, while the dominant goat breeds was the Sahelian type and the West African Dwarf goat.

#### **4.2 Background characteristics of the twenty farmers interviewed in the study sites**

Table 1 shows the background characteristics of farmers interviewed in the study sites. Sixty percent of the farmers were between the ages of 20 – 50 years. None (0) was less than 20 years old. Males were more than females (15 males vs 5 females). Ten farmers (10) representing 50 % of the farmers were married, 6 representing 45 % were single while One person (5 %) was divorced. Regarding their educational status, Forty-one percent (41%) of the farmers had their education up to the secondary level, 18 % had up to the tertiary level, 5.9 % had primary level education, while 35% did not have any form of formal education. Regarding their sources of income, 71 % got their income from the sale of livestock, but 29 % got their income from sale of livestock products.

**Table 4.2: Background distribution of farmers interviewed in the study site**

Characteristics	Frequency	Percentage %
<b>Age</b>		
Least than 20	0	0
20-50	12	60
More than 50	8	40
<b>Sex</b>		
Male	15	75
Female	5	60
<b>Marital Status</b>		
Married	10	50
Divorced	1	5
Single	9	45
<b>Educational Status</b>		
Tertiary	3	15
Senior High	7	35
Primary	4	20
None	6	30
<b>Income</b>		
Sales of livestock	15	75
Sales of livestock product	1	5
None	4	20

### **4.3 Husbandry practices**

#### **4.3.1 Management practices and constraints**

Table 4.3 shows that four farmer from the rural sites representing 40 % practiced intensive system, while 6 farmers from the urban sites practised the intensive system of management. Four (4) farmers from the urban sites used the semi-intensive system with the remaining 6 farmers representing 60 % used the same method from the rural sites. None of the farmers interviewed for the study from both rural and urban sites practiced the extensive system.

**Table 4.3: Livestock management practices by farmers in the rural and urban sites**

Practices	Study Site		
	Rural	Urban	Total
<b>a. Management System</b>			
Intensive	4	6	50
Semi-Intensive	6	4	50
Extensive	0	0	0
<b>b. Pesticide usage</b>			
Yes	7	4	55
No	3	6	45
<b>c. Use of veterinary services</b>			
Yes	5	7	60
No	5	3	40
<b>d. Management constraints</b>			
Poor veterinary services	2	1	15
Inadequate grazing land	8	7	75
Inadequate irrigation	1	2	15
Facilities and occurrence of diseases	0	0	0

Practices	Study Site		Total % of farmers
	Rural	Urban	
<b>e. Herd/Flock</b>			
<b>Livestock that died in the past 6 months</b>			
Cattle (25 kraals)	9	16	
0	6	9	75
<5	3	2	20
5-10	1	0	5
Sheep (20 pens)			
0	4	5	45
<5	5	5	50
5-10	1	0	5
Goat (8 pens)			
0	8	6	70
<5	1	3	20
5-10	1	1	10
<b>Signs and symptoms of infestation of ectoparasites</b>			
Scratching (wounds and lesions)	1	1	10
Loss of weight	2	2	20
Disease transmission and deaths	7	7	70

#### **4.3.2 Herd/ Flock health: Farmers awareness on arthropod ectoparasites**

Eighty percent (80 %, n = 16) of the 20 respondents from both rural and urban areas acknowledged being aware of arthropod ectoparasite infestations on their livestock (Table 4.3). This was clearly manifested by the high percentage (55 %, n = 20) of farmers using acaricides on their livestock and reporting that the infestation was more severe during the rainy season in both rural and urban sites. According to them, during the dry season when the sun is very hot there are few ticks seen. Measuring the direct and indirect effects of arthropod ectoparasite infestations on livestock productivity would need more time, hence the study investigated the perception of farmers on this issue. It was found that 4 farmers (20 %; n=20) perceived that arthropod ectoparasite infestations cause weight loss to livestock (Table 4.3), which indirectly affects milk yield, meat quality and quantity negatively resulting in low income. According to the farmers, the ticks are more abundant when there is more milk, that is during the rainy season but because of their indirect effects (wounds, bruises) on the teats or udder, some animals are not milked. Approximately ten percent (10.0%) revealed that many wounds and lesions on livestock are as a result of scratching due to arthropod ectoparasite infestations (Table 4.3), which they attributed mainly to tick and flea infestations, 20 % said they have less knowledge on the effects on livestock. About 5 % of the twenty-five sampled kraals had five to ten cattle deaths six months preceding this study (Table 4.3), and 5 % had more than ten deaths. Also, 65.2% of the farmers recorded no death in the cattle. Out of 28 sampled flocks, 50 % had more than five small ruminant deaths, and only 11 % had 5 - 10 deaths. Approximately 15 % (n = 3 of the 20 farmers) complained about poor veterinary services (Table 4.3), manifested by the high percentage (55 %) who conduct treatment of their animals themselves. Furthermore, 60 % (n = 12) reported that they receive treatment from the

Veterinary Service Department of the Ministry of Food and Agriculture (MoFA) from both rural and urban sites (Table 4.3). About seventy five percent (75 %, n = 15) of farmers complained of inadequate grazing area. Those in the urban sites specifically Ashaiman were faced with such problems and advocated for more lands to be provided. Fifteen percent (15%) farmers in the rural and urban sites also complained of inadequate irrigation facilities and occurrences of diseases among livestock (Table 4.3).

#### **4.4 The prevalence of arthropod ectoparasites on ruminant livestock (cattle, sheep and goats) in rural and urban areas**

The ectoparasites were found on both small and large ruminant livestock. These ectoparasites included the ticks, lice and mites. Majority of the ticks were found on the large ruminants while the majority of the mites and lice were found on goats and sheep.

##### **4.4.1 Ruminant livestock examined for presence of ectoparasites**

Arthropod ectoparasites were sampled from 830 ruminants (350 cattle, 200 sheep and 280 goats) from the 25 kraals of cattle and 28 flocks of small livestock (20 flock with sheep only, 6 flock with goat only and 2 flock with both sheep and goat mixed).

**Table 4.4: Number of ruminants in the urban and rural sites examined for presence of arthropod ectoparasites**

Site	No of farmers	Number of ruminants			
		Cattle	Goats	Sheep	Total
Urban	10	60	100	100	260
Rural	10	290	180	100	570
Total	20	350	280	200	830
Dominant breeds		Zebu	Sahelian type	Nungua black head	
		Sanga	West African Dwarf		
		Gudali			
		Ndama			

The arthropod ectoparasites collected were lice, ticks and fleas

#### **4.4.2 Prevalence of arthropod ectoparasite infestations on ruminant livestock in the 3 livestock management systems**

Table 4.6 shows that the least infested animals were found in the intensive management system, while the semi intensive management system had the highest number of animals infested with arthropod ectoparasites. Less arthropod ectoparasite infestations were found on livestock in the intensive system with better body condition. This is because livestock were owned and monitored directly by household head or ones which have owners frequently visited them.

**Table 4.5: Prevalence of lice, fleas and ticks on ruminant livestock in the three livestock management systems**

Management systems	Number of ruminant positive for different ectoparasites				
	Lice	Fleas	Ticks	Total	Percentage %
Intensive	15	16	20	51	(14)
Semi-intensive	25	35	250	310	(86)
Extensive	0	0	0	0	(0)
Total	40	50	270	361	(100)

#### **4.4.3 Prevalence of arthropod ectoparasites on ruminant livestock in six selected sites in urban and rural areas**

Table 4.6 shows the arthropod ectoparasites found on ruminant livestock sampled in six selected sites in the urban areas (Ashaiman, University Farms) and rural areas (Kpong, Akuse, Teye Kwame and Agormeda).

**Table 4.6: Number of ruminants with arthropod ectoparasites from the rural and urban sites.**

Site	Livestock Type	No. of animals examined	No. of arthropod ectoparasites collected			
			Lice	Fleas	Ticks	Total
Ashaiman (Greater Accra Region)	Cattle	40	0	0	286	286
	Goat	55	0	20	0	20
	Sheep	50	65	55	0	120
	Sub-Total	145	65	75	286	426
University Farms (Greater Accra Region)	Cattle	20	0	0	123	123
	Goat	45	0	0	0	0
	Sheep	50	0	0	3	3
	Sub-Total	115	0	0	126	126
Belekope (Eastern Region)	Cattle	60	0	0	59	59
	Goat	45	0	0	0	0
	Sheep	20	0	0	0	0
	Sub-Total	125	0	0	59	59
Okwenya (Eastern Region)	Cattle	61	0	0	65	65
	Goat	45	0	0	0	0
	Sheep	25	0	0	0	0
	Sub-Total	131	0	0	65	65

Site		No. of animals examined	No. of arthropod ectoparasites collected			
			Lice	Fleas	Ticks	Total
Teye	Cattle	98	0	0	521	521
Kwame	Goat	45	0	20	0	20
(Eastern	Sheep	30	0	0	0	0
Region)	Sub-Total	173	0	20	521	543
Agormeda	Cattle	71	0	0	95	95
(Eastern	Goat	45	0	0	0	0
Region)	Sheep	25	0	0	0	0
	Sub-Total	141	0	0	95	95
	TOTAL	830	65	95	1152	1312

#### **4.5 Distribution of tick species on different parts of the body of cattle**

##### **4.5.1 Predilection sites of arthropod ectoparasites.**

A total of 1,152 ticks were assessed for the preferential sites of attachment (Table 4.7). The most preferred site of attachments was the abdomen region where 44.6 % of ticks were collected from. The udder/scrotum area was the next preferred site of attachment with 44.3 % of the ticks. However, this order of preference was not consistent for all the tick species found. For instance, the number of *Amblyomma variegatum* found in the abdomen was significantly higher than all the other species region with 56.1 % of ticks of that species collected from that site while all the other tick species had the udder as the most preferred site (Table 4.7).

**Table 4.7: Spatial distribution of four ticks species on the different parts of the body of cattle**

Number and Percentages of tick species on body parts of cattle						
Tick Species	Head (%)	Abdomen (%)	Udder/Scrotum (%)	Anal (%)	Tail (%)	Total
<i>Amblyomma variegatum</i>	2 (0.4)	324 (56.1)	177 (30.7)	49 (8.5)	25 (4.4)	577
<i>Hyalomma rufipes</i>	0 (0)	19 (18.5)	53 (51.5)	13 (12.6)	18 (17.5)	103
<i>Rhipicephalus microplus</i>	3 (0.7)	159 (36.3)	262 (59.8)	0 (0)	14 (3.2)	438
<i>Rhipicephalus decoloratus</i>	0 (0)	4 (23.5)	11 (64.7)	0 (0)	2 (11.8)	17
Total	5 (0.4)	506 (44.6)	503 (44.3)	62 (5.46)	59 (5.2)	1135

#### 4.5.2 *Amblyomma variegatum*

The *Amblyomma variegatum* mostly preferred the abdomen (56.1 %) and the Udder/scrotum (30.7%) regions and the least preferred region was the head (0.4 %) region.



Figure 4.1: Identification of *Amblyomma variegatum*

#### 4.5.3 *Hyalomma rufipes*

The *Hyalomma rufipes* mostly preferred the udder/scrotum (51.5 %) region and least preferred the head (0 %) region.



Figure 4.2: Identification of *Hyalomma rufipes*

#### 4.5.4 *Rhipicephalus* species

*Rhipicephalus decoloratus* and *Rhipicephalus (Boophilus) microplus* were all found to mostly prefer the udder/scrotum region (59.8 % and 64.70 % respectively). The least preferred site of attachment was the head and anal regions.



Figure 4.3: Identification of *Rhipicephalus decoloratus*

#### 4.5.5 Lice species

The mallophagan louse *Damalinia (Bovicola)* spp. was found on the dorsal parts of sheep and in between the fur and body of the sheep. Mostly those livestock brought from neighboring countries like Niger carried lots of lice on them due to their grazing sites and lack of application of any form of pesticides to them.



Figure 4.4: Identification of *Darmalinia* spp, a Mallophagan louse.

#### 4.5.6 Flea species

Fleas were predominantly found on the small ruminants only and most abundant in those houses that allow their livestock to go out to graze for a long period. The only species collected was the dog flea *Ctenocephalides canis*.



**Figure 4.5:** Identification of *Ctenocephalides canis*

#### 4.6 Distribution and abundance of ectoparasitic species in the Urban Study Sites

A total of 412 ticks were collected from the two study sites in the urban sites. Of the 412 ticks collected, 286 were from the kraals in Ashaiman with the proportions being 25 *Amblyomma variegatum* (8.74 %) and 261 *Rhipicephalus microplus* (91.36 %). A total of 126 ticks were collected from the University Farms at LIPREC in Nmai Djorn with the proportions being 45 *Amblyomma variegatum* (36.58 %), 19 *Hyalomma rufipes* (15.45 %), 2 *Rhipicephalus decoloratus* (1.62%) and 57 *Rhipicephalus (Boophilus) microplus* (46.34 %).

The most predominant lice species that was found was the *Damalinia (Bovicola) spp* was and in the urban areas and 65 lice were collected. The flea species that was predominantly collected was

the *Ctenocephalides canis* and 75 fleas were collected from the urban sites specifically Ashaiman as shown in Table 4.5.

#### **4.6.1 Distribution and abundance of ectoparasite species in the rural sites**

A total of 740 ticks were collected from the four study sites in the rural areas. Of the 740 ticks collected, 59 were from the Belekope site at Kpong and the proportions were *Amblyomma variegatum* (71.19 %) and *Rhipicephalus (boophilus) microplus* (28.81%). A total of 65 ticks were collected from the Okwenya kraal at Akuse with the proportions *Amblyomma variegatum* (38.46 %), *Hyalomma rufipes* (12.30 %), *Rhipicephalus decoloratus* (7.69 %) and *Rhipicephalus (Boophilus) microplus* (40.00 %).

At the Teye Kwame kraal at Somanya, 521 ticks were collected and the proportions were *Amblyomma variegatum* (60.07 %), *Hyalomma rufipes* (1.15 %), *Rhipicephalus decoloratus* (0.38 %) and *Rhipicephalus (Boophilus) microplus* (40.69 %). At the Agormenya site in Somanya 95 ticks were collected and the proportions were *Amblyomma variegatum* (50.52 %), *Hyalomma rufipes* (22.10%), *Rhipicephalus decoloratus* (4.2 %) and *Rhipicephalus (Boophilus) microplus* (23.15 %). *Amblyomma variegatum* constitute the most predominant species collected in all of the rural and urban sites. The flea species that was predominantly collected was the *Ctenocephalides canis* and 20 fleas were collected from the rural sites specifically Teye Kwame (Table 4.5).

#### **4.7 Spatial distribution of arthropod ectoparasites in the study sites**

The data of the different ectoparasite species and their relative abundance with respect to the GPS coordinates of their corresponding study sites was used to construct two maps due to the differences in proximities of the sites to each other in the two ecological zones.

##### **4.7.1 Spatial distribution of arthropod ectoparasites in the rural sites**

The map of the rural sites was drawn at a scale of 1 inch: 25 km to clearly show the different study sites. The densities of the different ectoparasitic species at each study site was pictorially shown in a pie chart at the corresponding GPS coordinates (Figure 4.7).

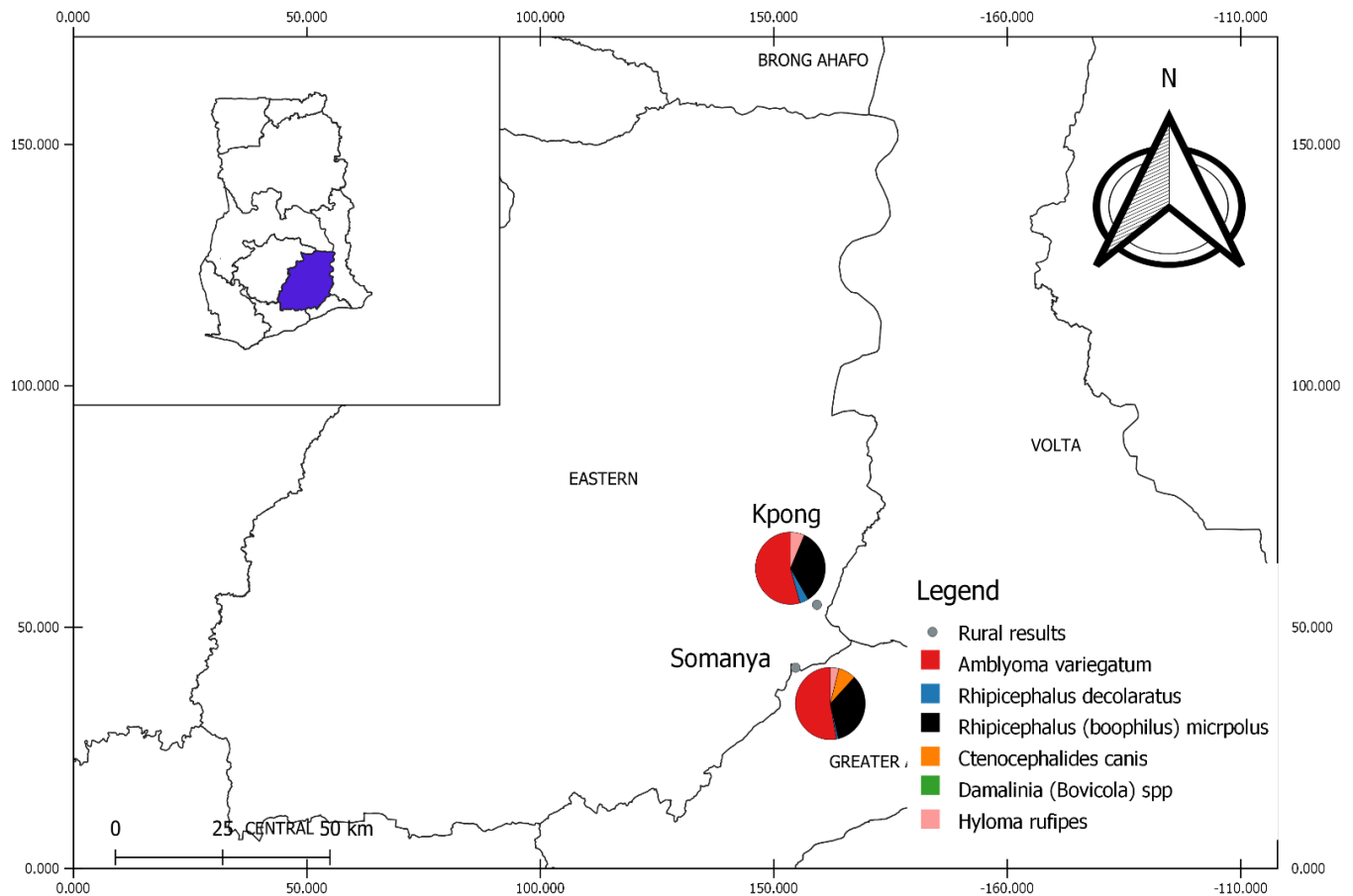


Figure 4.6: Spatial Distribution of arthropod ectoparasites species in the rural areas

#### 4.7.2 Spatial distribution of arthropod ectoparasites in the Urban Sites

The map of the urban sites was drawn at a scale of 1inch: 10 km due to the close proximity of the study sites to each other. The scale used made it possible to clearly show the different study sites. The densities of the different ectoparasitic species at each study site was pictorially shown in a pie chart at the corresponding GPS coordinates (Figure 4.8).

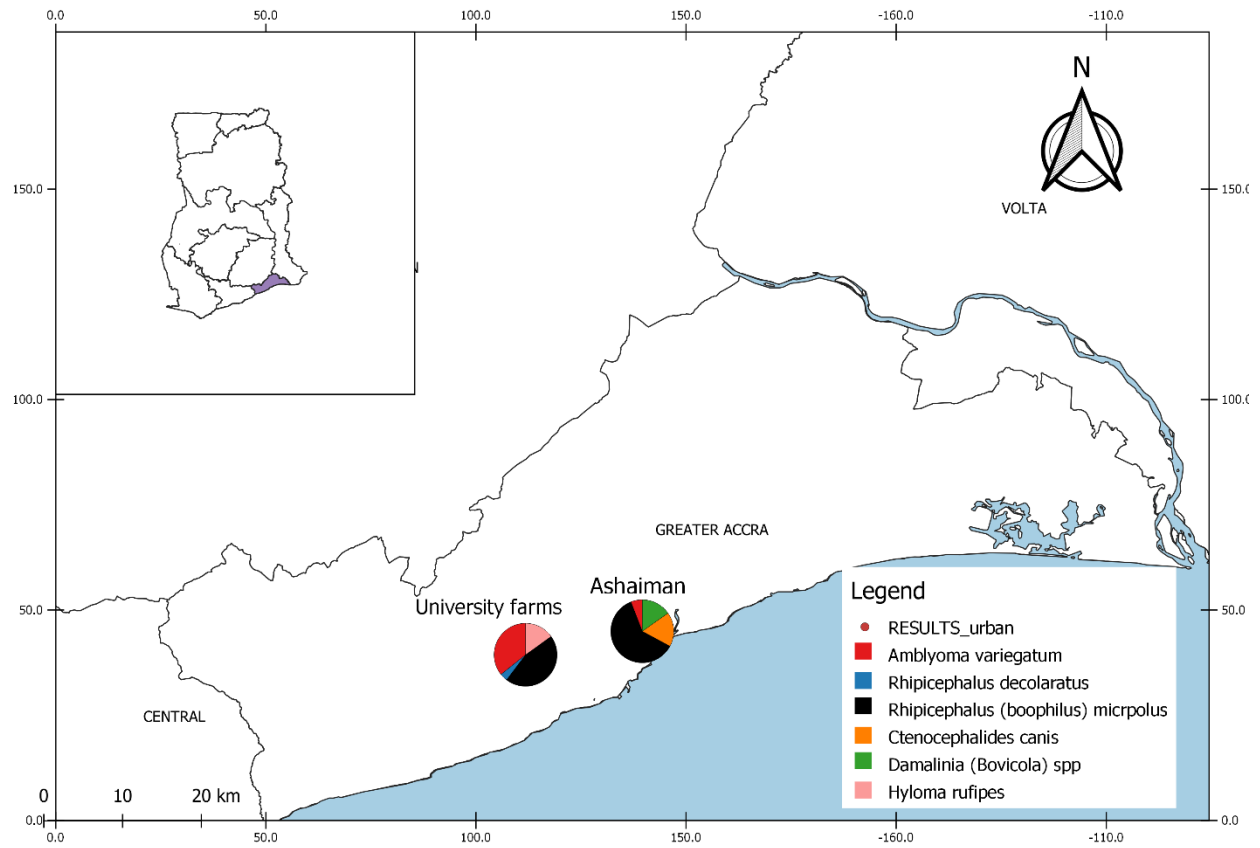


Figure 4.7 Spatial distribution of arthropod ectoparasites species in the urban areas.

**Table 4.8 Comparative analysis of ectoparasitic infestations in rural and urban sites.**

Species	Urban	Rural
<i>Amblyomma variegatum</i>	428	70
<i>Hyaloma rufipes</i>	19	35
<i>Rhipicephalus decoloratus</i>	5	11
<i>Rhipicephalus (Boophilus) microplus</i>	318	277
<i>Ctenocephalides canis</i>	75	55
<i>Damalinia (Bovicola) spp</i>	65	0

The data in Table 4.8 was analyzed using a Mann –Whitney test. It was found from the study that there was no significant difference ( $p > 0.05$ ).in the number of ectoparasite species gathered from both rural and urban locations. This implies that in both rural and urban locations, quite comparable numbers and species of ectoparasites can be discovered. There was also no statistically significant difference ( $p > 0.05$ ).

## **CHAPTER FIVE**

### **5.0 DISCUSSION**

#### **5.1 Livestock structure**

The livestock structure in the rural and urban sites that were sampled from revealed that most of the farmers rarely kept large numbers of both small and large ruminants. An average of 100 cattle for each kraal and 20 small ruminants per pen were notably observed. One of the many reasons for these low number of ruminant livestock is the inadequate grazing lands especially in the urban sites. Also, where these livestock are penned is a major source of concern. There is an inadequacy in terms of where they are kept and this results in low numbers of livestock kept. (Ashley and Annor-Frempong, 2004).

#### **5.2 Management systems practiced**

Turkson and Naandam (2003) found that the most commonly used management scheme was semi-intensive in assessing the veterinary requirements of ruminant animals in three districts in the northern region of Ghana. Only few small ruminant farmers in Kpong Soil and Irrigation Research Centre in Lower Manya District practiced the intensive system within the study sites as was also confirmed by Musa (2016). The main reason for this system of management being the most practiced is because of the unavailability of herders to handle large numbers of livestock in both rural and urban sites. Especially in the urban sites specifically in Ashaiman, most of the farmers kept very small numbers of livestock and practiced this intensive system because of the closeness of the pens and houses to principal streets and markets in the municipal areas. There is limited access to grazing lands.

The semi-intensive system of management of livestock was predominantly practiced by farmers in both rural and urban sites. This system of management involves the farmers allowing their livestock to go out into the open field to graze for a period of time, mostly between the hours of 8 am and 5 pm and the livestock returning afterwards to rest. (Musa, 2016). The reason why this system is so popularly used is because mostly the farmers are not well equipped and resourced to fully provide adequately for their livestock. Some farmers also spent little time at home and did not have herders to take good care of their livestock (Jayne et al., 2003; Otte and Chilonda, 2003). This system of management does favour ectoparasitic infestation. This is due to the fact that livestock are allowed to graze over long periods on the field thereby the likelihood of them coming into contact with vegetation that has ticks present on them. Another reason is that since the livestock are kept together in close proximity to each other there is a high probability that parasites could be spread easily among them. Semi intensive system also means that the kraals and pens are not adequately cleaned as compared to the intensive system where adequate attention is given to the shelters. (Chambers and Conway, 1992)

One of the things that was discovered during the study was the poor management skills of the farmers with regards to their livestock. Most often than not the inappropriate application of pesticides and acaricides on their livestock to control ectoparasites was a result of ignorance. This point highlighted by Turkson (1998) buttresses it. During the course of sampling one thing that was very prominent was the fact that most of the farmers kept their livestock for sales especially during Muslims celebrations thus they paid very little attention to the need to ensure that good management practices are observed.

Some of these cattle owners did not stay in the same place with the herders; as a result the herders had to consult them whenever there was need for treatment. This agrees with the findings of Turkson and Naandam (2003) who reported that herdsmen were the immediate people responsible for the animals upkeep, although they cannot take major decisions like payment of veterinary services, which are often referred to the owners who live in towns and are sometimes not easily reached.

Most of the livestock were heavily infested with ectoparasites because they were brought in from neighboring African countries example Niger and Ivory Coast where they had been exposed to long periods of grazing in open fields. These heavily infested livestock are managed under very bad husbandry practices including inappropriate application of acaricides which leads to resistance from these ruminant ectoparasites. This was echoed by (Asmaa *et al.*, 2014), who reported that bad husbandry practices of small farmers were found to be a determinant in making cattle more susceptible to tick infestation in a research undertaken in Egypt's Beni-Suef district.

### **5.3 Prevalence of arthropod ectoparasites**

Farmers from rural and urban sites that were interviewed showed a certain acknowledgement with regards to the presence of ectoparasites on their livestock. Most were quick to acknowledge the presence of ticks on their livestock especially when it was translated in their local dialects. This knowledge was evident in their quest to control these ectoparasites at all cost. This is in line with studies by Turkson and Naandam (2003) where they investigated traditional veterinary knowledge of local farmers and observed that farmers were solely focused on controlling ticks at all cost.

Majority of the farmers had little or no knowledge of other ectoparasites such as fleas and lice. They took little notice of them and thought they were just a nuisance to the livestock without seeking to control them effectively. Some actually had to be shown samples of these ectoparasites before they could relate seeing them on their livestock. Some just were not observant enough to even notice the presence of such ectoparasites on their livestock. This agrees with (Angyirereyiri *et al.*, 2015) who stated that livestock farmers do not take ectoparasite infestations seriously. They recommended that Veterinary Extension Officers intensify their outreach activities in order to succeed in the control of ectoparasites in the Kassena-Nankana East Municipality of the Upper East Region of Ghana.

Farmers also had a major constraint in controlling ectoparasites because of a lack of support from veterinarians especially in the rural sites. This made farmers resort to applying chemicals which were either not properly applied or that were not appropriate and led to resistance of ectoparasites. Most of the chemicals they applied included amithrax which are used to control ticks and Kepromec Pour-on which is an ivermectin and cypermetrin. The ivermectin is usually applied from the top of the head to the back.

Majority of the small ruminants had lower tick infestation but higher flea and lice infestations, unlike the cattle which had high tick infestation rates. In the small ruminants, this could be due to their low interaction with other flocks as well as the improved husbandry practice in terms of regular pen cleaning (Kusiluka *et al.*, 1998) and use of injectable Ivermectin to control these parasites. The high rate of tick infestation in cattle could be attributed to the husbandry practices considering the grazing time cattle are on the field when temperatures are low and sequestering

ticks are quite active during that period which could lead to infestations. The presence of fleas on small ruminants kept in pens could be attributed to the biology of these particular insects. Unlike lice the fleas feed at intervals and after feeding, they leave the host and hide in dark places (corners or crevices); as such where the spot acaricide application to animals is carried out, it does not affect the fleas as observed in the present study (Musa, 2016).

Ticks serve as important disease vectors in the tropical and subtropical areas and cause major financial losses by affecting animal health and productivity (Rajput *et al.*, 2006). The greatest effect on animal health is generally created by species belonging to only three genera, namely, *Amblyomma*, *Hyalomma*, and *Rhipicephalus* (Rajput *et al.*, 2006). Ticks are also capable of transmitting infectious pathogens that affect both livestock and humans (Parola and Raoult, 2001). For a tick to survive in an environment, some conditions including an optimal temperature and humidity as well as the availability of a suitable host are required (Uspensky, 2014). Pathogens transmitted by ticks can be pathogenic fungi, protozoa, viruses and bacteria (Brites-Neto *et al.*, 2015). A study carried out in Kumasi revealed the presence of Crimean-Congo Haemorrhagic Fever Virus (CCHFV) in ticks with a seroprevalence of 5.7 % in abattoir workers (Akuffo *et al.*, 2016). This finding suggests that the virus may have been transmitted by the reservoir vector tick species to the livestock increasing the risk of exposure to the animal handlers. More recently, Dugbe virus has been successfully isolated for the first time in Ghana from collected ticks (Kobayashi *et al.*, 2017). These studies indicate the need to understand the dynamics of tick populations to formulate efficient control strategies and potentially prevent future outbreaks.

#### 5.4 Abundance of ticks at the various study sites

Ticks in this study were collected from both rural and urban sites located in the Greater Accra and Eastern Regions. The use of hand picking of ticks from cattle was employed in the sample collection. This method had previously been used successfully to collect ticks from certain domestic dogs and cattle at the Kumasi abattoir in the Ashanti Region of Ghana. The study showed that the various tick species belonged to the genera *Rhipicephalus*, *Amblyomma* and *Haemaphysalis* (Akuffo *et al.*, 2016). A similar method of tick collection was used in a study conducted in Accra yielded diverse tick species (Kobayashi *et al.*, 2017). Tick species identified from the rural and urban sites located in the Greater Accra and Eastern Regions in this study, were predominantly of the genera *Amblyomma* followed by *Rhipicephalus* and the least being *Hyalomma*. It was further observed that *Amblyomma variegatum* was the most collected species of ticks whereas *Rhipicephalus decoloratus* was the least collected. The high number of *Amblyomma variegatum* species collected from all the study sites indicate that this species is common and poses a threat to public health because of their ability to transmit tick-borne infections (Ogo *et al.*, 2012). This species has been implicated in the transmission of CCHF (Akuffo *et al.*, 2016) and Dugbe virus (Kobayashi *et al.*, 2017) in Ghana. It should also be noted that other tick species identified in the study sites are capable of spreading various pathogens of veterinary and zoonotic importance (Reye *et al.*, 2012).

The tick density needs to be over a certain threshold for the transmission cycles tickborne pathogens to occur. This means that a higher density of ticks will mostly result in more efficient pathogen transmission cycle (Ogden *et al.*, 2007). Different entomological indices have been used to quantitatively express vector density, however, because of the limited data of tick abundance

the thresholds of different pathogen transmission of the different tick species in Ghana is still undefined. Determining the species abundance is a good first step in determining the vector density in a geographical area for subsequent studies into pathogen transmission cycles. In the urban sites in the Greater Accra Region, *Rhipicephalus spp* was the predominant species collected in both Ashaiman and University Farms. *Rhipicephalus microplus* were the highest number collected from both sites. It was observed that *Hyalomma rufipes* were only identified in samples collected from University farms. In the rural sites, *Amblyomma variegatum* was also identified to be the most predominant species of tick. The second highest prominent tick was *Rhipicephalus microplus*.

The high density of *Amblyomma variegatum* suggests that they may be involved pathogen transmission. Viral pathogens have been detected and confirmed in *Amblyomma variegatum* in Ghana (Akuffo *et al.*, 2016; Kobayashi *et al.*, 2017), making it a very relevant species and therefore needs to understand its ecology and distribution across the country. Although, *Hyalomma* species were of lower densities, their role in the spread of disease pathogens cannot be ignored as some studies suggest that they can be vectors of CCHF (Spengler and Estrada-Peña, 2018). Finding the above-mentioned species in Ghana indicates the need to conduct a nationwide surveillance to fully access their population structure and furthermore the burden of pathogens they carry. With the import of livestock from countries such as Burkina Faso, there is a possibility of invading tick species and consequently pathogens which would otherwise not be originally found in Ghana.

### **5.5 Preferred sites for attachment of different ectoparasite species on livestock**

This study revealed that a high percentage of tick species preferred for the abdomen and udder or scrotum of the cattle with the most predominant species being *Amblyomma variegatum*. This could

be as a result of the tick preferring to usually seek a suitable attachment point on the host where maximum blood feeding can be achieved. Body count score characteristics such as thickness of the host skin, relative humidity, blood circulation and grooming by de-ticking are some relevant roles in the selection of attachment sites by ticks (Ogden *et al.*, 1998). The lowest number of ticks were identified from the head of cattle probably due to the fact that they would be more exposed to extreme temperatures and potential predators.

High temperatures can cause dehydration in ticks leading to death. *Amblyomma variegatum* was found at each sampling site on the cattle and had a high preference for the udder or scrotum and the abdomen. These species are hunters which go in search of a suitable host, climb it and locate a safe spot where it will attach and feed without any form of external interference. Although *Rhipicephalus* spp were found at each sampled site on the cattle hosts, they were observed to have a high preference for the udder or scrotum. It was observed during the study that the animal handlers had used some insecticides to control the tick populations. This may have affected the proportion of ticks collected from the sites. However, the fact that many adult ticks were collected even three to four weeks after the application of the acaricides indicates that the tick may be resistance to the acaricides being used. There is the need for advanced research on the acaricide resistance pattern of the ticks in the areas of study. The insecticides used may have also had an influence on the proportions of ticks and ultimately their site of preference on the cattle host. This may account for the low numbers of *Rhipicephalus* spp at the points of attachment on the hosts.

Even though ticks can be controlled in numerous ways, each procedure for the elimination of the ticks may have a limitation. An example is the use of chemicals with acaricides which has resulted

in the tick species becoming more resistant (Martins *et al.*, 1995). Problems arising from the use of acaricides which are toxic and expensive, increase in resistant tick species, play a role in influencing the formulation of more effective control measures such as the continuous use of vaccines (Rajput *et al.*, 2006).

The collected chewing lice, *Bovicola* (presently called *Damalinia*) were found mainly at dorsal part of sheep where the hair was dense. Kids and lambs infested with fleas and lice were seen grooming their legs and parts of the body they can reach, every two to three minutes, at times scratching their bodies against fixed objects. Adults were observed using the latter approach more often to relieve the discomfort caused by these ectoparasites. This behaviour contributed to the many bruises on the legs and other parts of the body of the animals, some of which developed secondary infections that resulted in festering sores. These parasites affected the livestock negatively, causing blood loss, wounds, lesions, reducing grazing and as well as reduced ruminating time (Musa, 2016).

## CHAPTER SIX

### 6.0 CONCLUSION, RECOMMENDATIONS AND LIMITATIONS

#### 6.1 Conclusions

This study revealed that livestock farmers in the rural and urban sites are aware of tick infestation and their effects on their production than the other arthropod ectoparasites like lice and fleas detected on their ruminants. These farmers need the right education and knowledge on these parasites to ascertain how to go about controlling them. These parasites as a matter of fact have a high incidence of infestation on the affected animals mostly prevalently on small ruminants. These parasites should be treated with all seriousness to avoid any adverse effects. There is the need to gather relevant information concerning these parasites since they are anthroponotic.

With regards to tick infestation which was very prominent in the livestock, the high numbers of *Amblyomma variegatum* are serious health concern because they are capable of harboring and transmitting several infectious zoonotic diseases. Crimean-Congo hemorrhagic fever virus and Dugbe virus are some of the pathogens that have been detected and isolated in Ghana.

A high proportion of tick species identified from this study were observed to have a preference for the udder or scrotum of the cattle with the most predominant species being *Amblyomma variegatum*. The prevalence of these three genera of ticks known to be vectors of various infectious pathogens in the study sites highlight the desire to investigate more about ticks to improve the knowledge of vector dynamics, ultimately leading to the formulation of effective control strategy. The rural areas had a higher proportion of ectoparasitic infestation due to the favourable conditions in that ecological zone and the large numbers of cattle, sheep and goats in general.

Arthropod ectoparasite infestations lowered the body condition and increased production cost as confirmed by the farmers and lowered ruminant livestock output in the study area, which negatively affected the productivity and income of the farmers.

## **6.2. Recommendations**

From the results of this study, it is suggested that;

Further study will be carried out to evaluate the effect of ectoparasites on free-range and national livestock's health and performance. The cost-effectiveness of control strategies and thorough seller education should be performed by the competent officials to assist control these ectoparasites at low cost. Acaricide susceptibility and resistance levels in the ectoparasites should be studied to determine the best insecticides needed to control ticks in the country.

## **6.3 Limitations and Constraints**

In both rural and urban sites, farmers of especially the small ruminants had a very passive outlook when their permission was sought in order for the research to be conducted. Some sought to use this as a tactic to extort monies even after explaining the project to them. A few uneducated ones showed a lot of apathy towards us and some even mistook us for veterinarians and would not listen to us. The very few we managed to convince to allow us sample from their livestock had really poor management skills and only a few knew about ticks making the work cumbersome and difficult to explain.

Sampling from cattle was not very easy as farmers especially in the urban areas were reluctant to help restrain the animal for easy collection of ticks. A major reason for this was because most of the farmers were not available upon reaching the houses and mostly left their livestock in charge

of herders and family members who needed permission before taking decisions concerning the livestock. A classical example was one in Somanya where a farmer we had agreed to sample from his cattle left the kraal in charge of a herder. Contrary to the agreement was the fact that the herder was not ready to assist or allow us to sample from the cattle for no apparent reason even after the farmer had informed him to allow us to sample.

Due to financial constraints, the molecular analysis of the tick species to ascertain the presence of pathogens like like *Babesia bovis* and *Anaplasma marginale* from the collected arthropod ectoparasites was not actualized.

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**APPENDICES**

**APPENDIX A**

**Appendix A: Individual Questionnaire**

**COMPARATIVE ASSESSMENT OF ECTOPARASITIC INFECTIONS IN URBAN AND RURAL LIVESTOCK PRODUCTION IN GHANA.**

**Fill space and circle or tick the appropriate option General Information**

**Enumerator:.....Serial No.:..... Date:..... A.**

**Background** 1.1 Administrative District.....

1.2 Region:.....

1.3 Name of Village:.....

1.4 Name of farm/farmer:.....Tel:.....

1.5 Sex: (a) Male (b) Female

1.6 Educational level: (a) Tertiary (b) Senior School (c) Primary School (d) others (please

1.7 Age (years): (a) less than 20 (b) 20-50 (c) more than 50

1.8 Marital status: (a) married (b) divorced (c) single (d) widowed (e) separated

1.9 Why are you keeping livestock? (a) Consumption (b) sale (c) fertilizer (d) others (please specify).....

1.10 How did you get your initial stock? (a) Inherited (b) purchased (c) others (please specify).....

1.11 Source of family income: (a) sale of livestock (b) sale of livestock product (c) both „a“ and „b“ (d) others (please specify).

**B. Livestock Structure Number of Livestock kept**

Livestock	< 10	10-50	50-100	100-500	>500
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**species**

2.1 Cattle

2.2 Sheep

2.3 Goats

**C. Husbandry practices**

3.1 What management system are you practicing? (a) Intensive (b) semi-intensive (c) Extensive (d) others (please specify).....

3.2 Do you isolate new stock? Yes No

3.4 When do you release your animals for grazing? (a) Before 8 am (b) 8-10 am (c) after 10 am (d) Others (please).....

3.5 When do they come back from grazing? (a) Before 4 pm (b) 4-6 pm (c) after 6 pm (d) Others  
(please).....

3.6 How often do you move/clean the holding ground? Underline the applicable one. (a) Once in  
a month (b) twice in a month (c) others (please specify).....

3.7 Do you use pesticides (Insecticides and/or Acaricides)? Yes (b) No D. Income and  
Expenditure

4.1 Do you pay a herder? (a) Yes (b) If No .....Skip to Q 4.2

4.1.1 how much do you pay him/her per month? (a) less than GH 500 (b) GH 500 to 1000 (c)  
more than GH 1000

4.2 Do you sell milk? (a) Yes (b) No ..... Skip to Q4.3

4.2.1 How much do you get from selling milk monthly? (a) Less GH 100 (b) GH 100 to GH 500  
(c) more than GH 500

4.3 Do you sell livestock? (a) Yes (b) No ..... Skip to

Q4.4 How much do you earn from livestock sales annually? (a) less than GH 500 (b) GH 500 to  
1500 (c) more than GH 1500

4.5 Do you use farm yard manure on your farms? (a) Yes (b) No

4.6 Do you have cattle as draught animals? (a) Yes (b) No

4.6 How much did you spend on livestock treatment for the past 6 months? (a) less than GH 100

(b) GH 100 to 500 (c) more than GH 500

### **E. Herd/flock Health**

5.1 Do you encounter ectoparasites problems on your livestock? (a) Yes (b) No...Skip to Q 5.6

5.2 Which ectoparasites? (a) Lice (b) ticks (c) fleas (d) others (please specify)

5.3 What time of the year do you mostly have this problem? (a) Rainy season (b) dry season (c)

others (please specify).....

5.4 What effects do these ectoparasites have on your livestock? (a) Loss of weight (b) wounds

(c) Mastitis (d) others (please specify)..

5.5 Who treats these ectoparasites on your livestock? (a) Call a veterinarian (b) do it by myself

(c) others (please specify)...

5.6 What kind of medication do you use on your livestock? (a) Local herbs (b) conventional

medicine (c) others (please specify)...

5.7 How many ruminant livestock have you lost in the past 6 months?

Cattle (a) less 5 (b) 5 to 10 (c) more than 10. Sheep (a) less 5 (b) 5 to 10 (c) more than 10. Goats

(a) less 5 (b) 5 to 10 (c) more than 10

5.8 What signs and symptoms did you observe on them before they died? (a) Scratching (b) limping (c) loss of weight (d) Others (please specify).....

5.9 How did you dispose of the carcass (es)? (a) Bury them (b) throw them away (c) Burn them (d) others (please specify).....

5.10 Do you receive advice from veterinarians? (a) Yes (b) No

5.11 What are the most serious constraints facing ruminant production in your area (here)? (a) poor veterinary services (b) inadequate grazing land (c) Others (please specify)...

5.12 What type of support do you think will help to improve ruminant livestock production/productivity in this area? (a) Improved veterinary services (b) availability of veterinary drugs (c) availability of grazing land (d) Others (please specify).....

5.13 Do you have any question or comment?.....