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Prevalence and Distribution of Camel Ticks in Gola Oda Woreda East Hararghe Zone, Oromia Regional State, Ethiopia

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Abstract

The study was carried out in the Gola Oda woreda, situated in the eastern Hararghe zone of the Oromia regional state in Ethiopia, spanning from April 2023 to October 2023. The primary aim of the study was to evaluate the prevalence of tick infestation and identify the specific tick genera affecting camels. The investigation covered four Peasant Associations (PAs) – Gara Gafa, Cophi Mi'awa, Bareeda Lenca, and Burqa. Adult ticks were gathered from various regions of the camels' bodies. Out of the 384 camels examined, a comprehensive tick infestation prevalence of 76.8% was noted in the study area. Specifically, 50 camels from Burqa, 76 from Bareeda Lenca, 74 from Cophi Mi'awa, and 95 from Gara Gafa were infested with ticks, with prevalence rates of 75.8%, 70.4%, 82.2%, and 79.2% respectively. A total of 3145 adult tick genera were collected and identified using direct stereo microscopy, including Rhipicephalus, Amblyomma, Hyalomma, and Boophilus. The sole statistically significant difference observed was in the body condition of the camels ($p<0.05$), while no significant difference was found in tick infestation between the origins of the camels ($p>0.05$). The high prevalence of tick infestation in the study areas may be attributed to poor management practices, favorable climates, lack of awareness among farmers, and inadequate veterinary health extension services. Consequently, immediate prevention and control strategies are imperative in these regions.

Keywords: Camel; Genera; Gola Oda; Prevalence; Tick

Introduction

Ethiopia is acknowledged for having the largest livestock population in Africa, with the livestock sector playing a significant role in the country's economy. The camel, renowned for its adaptability to arid and semi-arid environments, is a versatile animal crucial for enabling pastoralist communities to thrive in challenging conditions [48]. Ethiopia ranks third in Africa for its high population of camels, with approximately 1,102,119 camels mainly found in the Southern, Eastern, and North Eastern arid and semi-arid regions like Ogaden, Borana, and Afar [10]. The one-humped camel holds great importance in Ethiopia's pastoral economy due to its ability to survive in areas with limited vegetation [16], a trait expected to become more vital as land degradation and human population growth continue [8].

Ethiopia's diverse agro-climatic zones and varied environment create favorable conditions for various livestock diseases [17], with ticks being identified as significant ectoparasites globally [23]. Ticks pose a major challenge to the health, productivity, and performance of domestic animals due to their blood-sucking activities [30]. They have the ability to transmit a wide range of pathogenic microorganisms, including protozoa, rickettsial, bacterial, spirochetes, and viruses. In Africa, diseases like Theileriosis, Babesiosis, Anaplasmosis, Rocky Mountain spotted fever, heartwater (cowdriosis), Tularaemia, Lyme disease, Relapsing fever, Louping ill, and African Swine Fever are primary concerns for livestock health and management (Urquhart et al., 1996). Tick infestation in one-humped camels can lead to mild to severe anemia, loss of appetite, reduced growth rate, decreased productivity, and direct damage through feeding habits and secondary infections. Tick paralysis in camels is

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a rare occurrence reported only in Sudan and is believed to be caused by specific tick species [33].

There are two main families of ticks: the Ixodidae, also known as “hard” ticks due to their tough dorsal shield, and the Argasidae, referred to as “soft” ticks because of their flexible leathery cuticle. The Ixodidae family comprises approximately 80% of all tick species, including those of utmost economic importance. In Africa, the predominant ticks crucial for livestock health belong to about seven genera, such as Amblyomma, Boophilus, Haemaphysalis, Hyalomma, and Rhipicephalus, commonly found in Ethiopia. There exist 20 species of ticks that affect livestock, all of which have adverse impacts on production and productivity [6,21].

Camels are typically found in the dry subtropical regions of Africa and Asia. In Ethiopia, there are around 1.06 million camels primarily located in the arid and semi-arid areas of the Southern, Eastern, and North Eastern regions of the country, notably in Borana, Ogaden, and Afar regions [22]. However, camel husbandry encounters challenges stemming from various diseases, limited veterinary services, insufficient feed supply, and internal as well as external parasitic infections. Ticks pose a significant obstacle to the global livestock sector [12,24], impeding animal production in tropical and subtropical zones by transmitting fatal pathogens to livestock. This transmission leads to blood loss, damage to hides and udders, and paralysis [44].

Despite the crucial role camels play in the livelihoods of Ethiopian pastoral communities and the potential impact of ticks on their productivity, information regarding camel ticks in Ethiopia is scarce. Camels in the Gola Odaworeda face consistent risks of tick infestations and tick-borne illnesses. While various methods for controlling tick infestations in the region exist, the challenge persists due to limited coverage of households by current control measures. Moreover, there has been no specific study conducted on the prevalence of tick infestations in camels in the Gola Oda. Hence, this study aims to assess the prevalence of ticks on camels and identify the genera of ticks present in the Gola Oda Woreda.

Camel Ticks

General Characteristics

Ticks belong to the group of arthropods closely related to insects and spiders, distinguished by their lack of a spine. They are placed within the phylum Arthropoda, the class Arachnida, and the order Acari [49]. The infestation of domestic animals by ticks is termed acariasis, referencing their classification within the Acari group (Hendrix, 1998). There exist two main families of tick species: Argasidae and Ixodidae. Argasidae ticks, known as soft ticks, do not have a hard scutum on their bodies and include a significant genus, Ornithordores, known for infesting cattle, where they feed while remaining on the host permanently [49].

On the other hand, Ixodidae ticks, commonly recognized as hard ticks, primarily serve as disease vectors. This family encompasses well-known genera like Boophilus, Amblyomma, Rhipicephalus, Haemphysalis, Dermcentoer, Ixodes, and Margaropus, which are often found infesting cattle [49]. Both families share a similar developmental pattern with six-legged larvae and eight-legged nymphs, progressing through molting stages to reach adulthood. To locate their hosts, ticks from both families possess various chemoreceptors and Haller’s organ situated on the tarsus of their first pair of legs (Kettle, 1995) [49].

Morphology of hard ticks: Camels can be infected by various genera of ticks. The most economically significant and commonly found ticks belong to the Ixodidae family, including the genera Amblyomma, Hyalomma, Boophilus, and Rhipicephalus. Ixodid ticks are characterized by a rigid chitinousscutum covering the entire dorsal surface of the adult male, while it extends only partially in the female, nymphs, and larvae to allow the abdomen to expand after feeding (Kettle, 1995). These ticks have a rounded body without a distinct boundary between the anterior and posterior parts, divided into two body components: the gnathostoma or capitulum (mouthparts) and the idiosoma, a fusion of head, thorax, and abdomen (Kaufmann, 1989).

The mouthpart consists of two small retractile mandibles, a pair of short palpi, and a toothed probe or hypostome projecting forward. Engorged females may significantly increase their weight, appearing round and plump due to the elastic cuticle of the female tick (Seifert, 1996). The presence or absence, shape, and size of morphological features like the anal groove, palpi, scutum, mouthparts, basis capituli, festoons, spiracle plates, ventral plates, adanal plates, subadanal plates, spur, and others play a crucial role in distinguishing between different genera and species of ticks [49].

Biology of ticks: Ticks can be classified into three groups based on the number of hosts they require to complete their life cycle: one-host, two-host, and three-host ticks (Urquhart et al., 1996). One-host ticks, such as all Boophilus species, undergo their entire development on a single host. Starting from eggs, the larvae attach to a host, where they mature into nymphs and then adults. The female tick detaches after mating and laying eggs, completing the cycle in approximately 19-21 days, but this timeline can vary based on environmental factors [49].

Two-host ticks, represented by species like Rhipicephalus and Hyalomma, hatch as larvae from eggs, attach to a host to feed and grow into nymphs. After dropping off the host onto the ground, they transform into adults within 20-30 days. The adult tick then seeks out another host for feeding, mating, and egg-laying [49].

Three-host ticks, which include species like Amblyomma, Dermacentor, Ixodes, and most Rhipicephalus and Hyalomma species, follow a more intricate life cycle. Larvae hatch from eggs on the ground, feed on a host, drop off to molt, and then nymphs search for a second host for feeding before molting into adults on the ground. The adult tick then requires a third host for feeding, mating, and egg-laying to complete the cycle. The complete life cycle of a three-host tick can extend up to a year due to variations in the duration spent in each stage on the ground [49].

Attachment sites: The specificity of tick attachment sites serves as a natural population control mechanism, confining ticks to specific areas on the host’s body. This restriction is shaped by factors such as the host species, environmental conditions, and tick behavior (Tatchell, 1987). Initially, ticks use their front legs to attach to hosts and then navigate across the skin to locate an ideal spot for feeding [49]. They tend to prefer sheltered areas on the host where conditions for their development are optimal and have a particular inclination towards specific regions of the skin for feeding [35].

The host’s grooming response to tick attachment site irritation can influence the distribution of ticks on the host’s body. In instances where hosts have short hair and are exposed to direct sunlight, insulation can impede successful attachment and engorgement on the animal's back. Some species exhibit preferences for specific attachment sites, where adult ticks are prone to attach (Tatchell, 1987). The selection of attachment sites on the host is guided by factors like ease of access for feeding, protection from environmental conditions, and the ability to overcome these obstacles. The location of ticks on the host is correlated with their potential to penetrate with their mouthparts. Species with shorter mouthparts, such as Rhipicephalus, Dermacentor, and Haemaphysalis species, typically attach to areas like the head (ear, eye, mouth corner), neck, anus, udder, and tail. Conversely, species with longer mouthparts, such as Amblyomma and Hyalomma species, tend to attach to lower body parts with thicker skin, including the dewlap, armpits, groin, udder, perineum, and around the anus (Potency et al., 1987). Smaller ticks like Boophilus do not exhibit a clear preference and can be found throughout the host's body [31].

Epidemiology of Ticks

Ticks inhabit a wide range of regions globally, including both temperate and tropical areas. There are approximately 825 identified tick species that feed on domestic and wild animals, as well as humans [49]. The family Ixodidae includes 13 genera and around 671 or more tick species. The epidemiology of ticks is divided into distinct phases: the free-living developmental phase, host-finding phase, and parasitic phase, all of which hold vital importance. During the free-living developmental phase of ticks in the external environment, factors like temperature and humidity significantly influence their development and overall growth [13].

Factors influencing the distribution of ticks: Intrinsic (Innate) Factors: Ticks exhibit a particular preference for specific host species, often within a cluster of related species, finding ideal conditions on hosts like camels and other members of the Camelidae family, along with wild animals such as buffalo. In open grasslands and savannas, certain tick species like Hyalomma and Rhipicephalus—such as H. marginatum and R. bursa—are actively attracted to hosts, minimizing risks associated with nymph attachment. Notably, ticks like Boophilus hold significant veterinary importance as one-host species. The degree of host specificity varies across various genera of ixodid ticks. In modern agricultural and livestock settings, ticks exhibit selectivity towards specific vertebrate groups based on their size and mobility [31].

The positioning of ticks on their host affects their ability to puncture with their mouthparts. Ticks with shorter mouthparts, like Rhipicephalus, Dermacentor, and Haemaphysalis, typically attach to regions such as the head (including inside the ear and the neck), the anal area, and beneath the tail on ungulates or camel species. Conversely, ticks with elongated mouthparts, such as Hyalomma and Amblyomma, favor areas with thicker skin on the lower body, like the dewlap, armpits, groin, udder, testes, perineum, and anal margin. Smaller ticks, including various stages of Boophilus and larvae and nymphs of Amblyomma, show no distinct preference and can be found throughout the host's body (Shah-Fisher and Say, 1989).

Extrinsic (Environmental) Factors: Prior studies in southwestern Ethiopia by Morel, Pegram et al. [36], and De Castro [13,32,36] classified the area based on factors like altitude, rainfall patterns, rain type, and primary vegetation, all impacting the distribution of tick species in the region. The viability and development of tick eggs and pupae, as well as unfed hatched ticks, rely on humid rather than excessively wet conditions. Furthermore, the daily activity patterns of ticks—be it during the day, morning, or evening—are influenced by the prevailing climatic traits of a given season and geographical area [31].

Life Cycle of Ticks

In the case of Ixodidticks, mating typically occurs while on the host, with the exception of Ixodes ticks, where mating can also occur while they are still on vegetation. Male ticks remain attached to the host and will seek to mate with multiple females during their feeding. Females mate just once before becoming fully engorged with blood. Once engorged, they detach from the host, holding ample stored sperm to fertilize all their eggs. Female hard ticks lay a substantial number of eggs, ranging from 2,000 to 20,000 in a single batch [49].

The life cycle of Ixodid ticks consists of four stages: egg, six-legged larvae, eight-legged nymph, and adult. Most hard ticks exhibit relatively limited mobility and adopt a sit-and-wait strategy rather than actively seeking hosts [50]. Ticks are categorized into three groups based on their host requirements throughout their life cycle: one-host, two-host, and three-host ticks [43].

In one-host ticks, all three stages feed on the same host, a less common life cycle type found in the entire Boophilus subgenus of Rhipicephalus and other genera [43]. Eggs are deposited on the ground, and upon hatching, larvae quest for a host on vegetation. After feeding, they remain attached to the host for moulting. Subsequently, the nymphs also feed on the same host, remaining attached. Following another moult, the adults emerge and continue to feed on the same host. This entire development cycle typically spans 19-21 days [49].

For two-host ticks, larvae and nymphs feed on the same host, with the adult seeking out a different host. Species like Hyalommadetriyum and Rhipicephalus everts follow a two-host life cycle, with the timing of nymphs on the ground crucial for finding a new host [46]. Three-host ticks necessitate a distinct host for each life stage, dropping off after engorgement to moult on the ground [43]. This is the most prevalent life cycle type, with three-host tick development being slower, lasting from six months to several years (Shah-Fischer and Say, 1989) [49].

Pathogenic Role of Ticks

Aside from causing physical harm and blood loss, ticks can pose a dangerous threat to their hosts through the toxins present in their saliva. These toxins have the potential to impact not only the attachment site but also specific tissues within the host's body. For instance, neurotropic toxins can trigger tick paralysis, while dermotropic toxins may induce sweating sickness (Shah-Fischer and Say, 1989). In substantial numbers, ticks can lead to hide damage, decreased productivity, anemia, and even fatality in animals. Moreover, they can contribute to heightened sickness and mortality during dry spells, causing delays in weight gain, necessitating longer retention periods for animals before they can be sold. Additionally, ticks play a crucial role as disease vectors [37].

Direct effect: Tick paralysis is a condition that impacts both humans and animals, manifesting as a sudden onset of weakness and motor function loss that initiates in the lower extremities and progresses upward. Failure to promptly remove the ticks can result in respiratory failure and potentially lead to fatality. This form of paralysis is commonly seen in young domestic animals with a heavy tick infestation. The degree of paralysis is usually associated with the length of time ticks have been feeding and the quantity of ticks affixed to the host [43].

Blood Loss: Ticks solely rely on the blood of their host as their source of nutrition [49]. Highly engorged species can ingest approximately three times the original blood volume before feeding (Shah-Fischer and Say, 1989).

Bite injury (wound): Upon biting, ticks induce local tissue damage and bleeding at the bite location, triggering an inflammatory response commonly characterized by the presence of eosinophils. Tick bites have the potential to become infected with staphylococcus bacteria, resulting in localized skin abscesses or pyemia [50].

Tick Toxicosis: Certain toxins generated by ticks might not exhibit a confined detrimental impact, but they can induce weakness in animals and sporadically foster the growth of protozoa that persistently inhabit the host. This situation signifies an escalation of the unique poisonous effect of the parasite's saliva (Shah-Fischer and Say, 1989).

Disease transmission: Ticks play a crucial role as carriers of animal diseases because of their feeding behavior, transmitting various harmful viruses, rickettsia, bacteria, and protozoa. Key diseases spread by ticks comprise babesiosis, anaplasmosis, theileriosis, Q-fever, cowdriosis, African swine fever, among others [50].

Treatment and Control

The treatment and management of ticks focus on addressing particular tick species according to their biological traits. The effectiveness of acaricides utilized for tick control relies on their strategic and systematic application. Having insight into tick behavior on host animals is essential for implementing successful control and elimination strategies (Seifert, 1996). There are three key techniques employed for tick management, with a recent inclusion in the strategies [37].

Acaricides: In tick control practices, acaricides like arsenic, Amitraz, cyhalothrin, dioxathion, ethion, diazinon, and injectable ivermectin are commonly employed. The selection of acaricides is influenced by factors such as their duration of effectiveness on the skin and fur, the likelihood of residual toxicity in milk or meat, and the potential for resistance development within local tick populations [37]. The frequency of treatments throughout the tick season may vary based on the susceptibility of nymphal stages to acaricides (Urquhart et al., 1996).

Pasture spelling: Time-honored practices such as burning pastures, eliminating indigenous wildlife, field pillowing, and rotating grazing patterns remain integral strategies for managing ticks in vast range settings [37,46].

Use resistant breeds: The introduction of Bosindicus cattle breeds has demonstrated potential in lessening the influence of ticks and diseases transmitted by ticks in comparison to Bos Taurus breeds. Studies from regions in eastern and southern Africa indicate that European cattle breeds typically host a greater variety of tick species than zebu breeds [42].

Vaccination: There has been encouraging progress in tick vaccination, where basic vaccines derived from extracts of partially engorged adult female B. microplus have displayed successful immunity. Additionally, a recombinant vaccine centered on a membrane-bound glycoprotein Bm 86 has been developed and proven to be equally effective as the original antigen in managing acaricidal-resistant ticks [37].

Tick Species Prevalent in Ethiopia

Extensive studies have been conducted to examine the distribution of tick species on livestock across various regions within the country. Surveys have been carried out in several locations including Jigjiga [3], the Eastern and Western Hararghe Zones [29], Shewa Zone [19], Jimma Zone [1], Wolayta in Southern Ethiopia [15], two districts in the Somali Regional State [38], Asella [45], Holeta Town [9], Chilga in North West Ethiopia [34], Mekelle [20], highland areas of Harar and Dire Dawa [6], Borana [5], and Haramaya town [7].

The boundaries of tick distribution are not rigid but influenced by a complex interplay of factors such as climate, host density, and host susceptibility [41]. Understanding these factors is critical for implementing effective tick and tick-borne disease management strategies. Knowledge of the geographical spread and prevalence of tick species is pivotal for the effective control of ticks and Tick-Borne Diseases (TBDs). A study in Ethiopia conducted by Mokonnen (1995) found Amblyomma (40%), Boophilus (20%), Haemaphysalis (0.5%), Hyalomma (1.5%), and Rhipicephalus (37%) to be prevalent, although over 60 species are known to exist in the country. The distribution of A. varigutum is akin to that of B.decoloratus [36]. Boophilusdecoloratus (28%) was the most prevalent tick species, with significant infestations observed on crossbreed cattle. Boophilusannulata is restricted to Gambella and South West Ethiopia. A. cohaerens is predominantly found in West Ethiopia [13], while R. pulchllus was mainly located in southeastern Ethiopia within the Rift Valley. R. e. everts are widespread across various climatic and ecological zones. A. gemma and R. pulchellus predominantly inhabit semi-arid regions [36].

An investigation in Mekele found that Boophilus infestations accounted for 53.6% of the total, whereas Amblyomma and Rhepicepulus infestations were 23.9% and 22.5% respectively. The study also noted that ticks infested cattle under extensive production systems at a significantly higher rate compared to those under intensive production systems (Yakob et al., 2008). In a study conducted on cattle in the Gibe valley of central Ethiopia, B. decoloratus infestations accounted for 34.2%, followed by A. varigatum at 29.8%, R. e. everts at 21.1%, R. praetexatus at 9.03%, A. cohaerens at 4.59%, R. camicasi at 0.59%, H. m. rufipes at 0.14%, and H. trunctum at 0.02%. The research also found that the dewlap and vertical areas of the cattle were the most favored feeding sites for the majority of the collected ticks [42].

Materials and Methods

Study Area

The study was conducted in the Gola Odaworeda of East Hararghe, Oromia Regional State, Ethiopia, specifically in four randomly chosen Pas: GaraGafa, CophiMi'awa, BareedaLenca, and Burqa. Situated between 09°08' N and 09°13' E latitude and 42°14' N and 42°23' E longitude, the area has an elevation ranging from 1182 meters above sea level and is located 846 km east of Addis Ababa. It is bordered by Bedeno to the north, Kumbi to the south, Garawa to the east, and Malka Belo to the west. Gola Oda experiences mid-subtropical temperatures ranging from 20°C to 35°C, with an average annual rainfall of 1700 mm. The soil composition primarily consists of clay, with pockets of black soil in certain regions. Gola Oda encompasses a topographical area of 4219.645674 km2. The livestock population in Gola Odaworeda includes approximately 931,475 cattle, 64,506 sheep, 2,134,047 goats, 17,439 donkeys, 50 mules, and 175,382 chickens. The total population in Gola Oda is 58,754, with 29,010 males and 29,744 females.

Study Animals

The study centered on one-humped camels (Camelusdromedarius) situated in randomly selected areas of the Gola Oda woreda. The research encompassed camels of varying ages and sexes, and in line with the information provided by the owners and De Lauta and Habel (1986), the sampled animals were categorized into two groups based on age: young (<3 years) and adult (>3 years). In adherence to the protocols outlined by Okello-Onen et al. [35], specific regions on the camels' bodies were meticulously inspected for ticks, including the ear, head, neck/brisket, foreleg, belly, hind legs, escutcheon, tail, and shoulder. The investigation involved selected Peasant Associations (Pas) like Gara Gafa, Cophi Mi'awa, Bareeda Lenca and Burqa within the Gola Oda woreda, East Hararghe Zone, Oromia Regional State, Ethiopia.

Study Design

From October 2023 to April 2023, a cross-sectional study was carried out to assess the prevalence of tick infestation and to identify the tick species infecting one-humped camels (Camelusdromedarius) in randomly chosen Peasant Associations (PAs) Gara Gafa, Cophi Mi'awa, Bareeda Lenca, and Burqa. Additionally, the research aims to investigate potential risk elements such as age, gender, origin, and overall physical well-being of the camels.

Sample Size Determination

The study's sample size, reflecting the total number of camels needed, was calculated using the formula outlined by Thrusfield [47] and employing a straightforward random sampling technique. Calculations considered a 95% confidence interval and 5% desired absolute precision. As there was no prior research available in this particular domain, a 50% expected prevalence was assumed to estimate the required sample size for this investigation. Therefore, the sample size was determined using the following formula.

$$n = \frac{1.96^2 X\, P_{exp}(1 - P_{exp})}{d^2}$$

where n represents the needed sample size, Pexp denotes the expected prevalence, and d stands for the desired absolute precision, the resultant calculated sample size was 384 animals.

Study Methodology

Sample collection: The camels underwent a thorough tick inspection, assisted by the camel owners or their helpers. Areas on the camels' bodies known to be tick-prone, such as the head, neck, sternum, beneath the tail, abdomen, scrotum/udder, and the back/side surfaces, were meticulously scrutinized using visual examination and skin palpation. Any visible adult ticks identified in these regions were carefully extracted and preserved in properly labeled collection vials containing 70% alcohol. These vials were annotated with details like the collection date, site, sex, age, and location on the body where the ticks were discovered. They were then conveyed to the Hirna Regional Veterinary Diagnostic and Research Laboratory for storage and tick identification, following the procedures recommended by Okello-Onen et al. [35] and Walker et al. [49].

Tick identification: The hard ticks gathered from each vial were moved to Petri dishes and scrutinized under a stereo microscope to classify them by genus, adhering to the tick identification protocols outlined by Walker et al. [49]. Essential characteristics utilized for identification purposes consisted of the scutum, anal groove, festoon (ornamentation), color, mouthpart size and shape, and leg color.

Data Management and Analysis

The assessment data was entered into an MS Excel spreadsheet and analyzed using STATA® version 11 for Windows. Descriptive statistics were used to investigate the prevalence of tick species and where they were found on the body. The Chi-square test was used to compare infestation rates based on age, gender, origin, and body condition. A 95% confidence interval with a 5% margin of error was used to determine if there were significant differences in the measured variables.

Results

Prevalence of Tick Infestation Based Origin of Camels

The study was conducted on camels in four Peasant Associations (PAs) – Gara Gafa, Cophi Mi'awa, Bareda Lenca, and Burqa – chosen randomly from the Gola Oda woreda. Out of the 384 camels surveyed, 295 (76.8%) were identified to have tick infestations. More specifically, tick infestations were observed in 50 camels from Burqa, 76 from Bareda Lenca, 74 from Cophi Mi'awa, and 95 from Gara Gafa, with prevalence rates of 75.8%, 70.4%, 82.2%, and 79.2% respectively. The statistical analysis indicated no substantial variance in tick infestation based on the animals' origin (p> 0.05) (Table 2).

Prevalence of Tick Infestation Based on Sex and Age Categories

Regarding sex, the study involved 234 female and 150 male camels, out of which 182 (77.8%) females and 113 (75.3%) males were identified as infested with various tick species. The statistical analysis revealed no considerable difference in tick infestation rates between the two genders ($_{\chi}2$=3.24, p= 0.058, p> 0.05). The prevalence of tick infestation in adult camels was 66% (101), while in young camels, it was 84% (194). Nonetheless, no statistically significant disparity was observed across the various age groups concerning tick infestation rates (p> 0.05).

The camels were classified according to Body Condition Scoring (BCS) into three categories: good, medium, and poor, with infestation rates of 54.3% (38), 74.4% (96), and 87% (161) respectively. A statistically notable divergence (p=0.000) in infestation rates was noted among camels with varying body conditions (Table 4).

Distribution of Camel Ticks Genera

The study collected 3145 adult ticks from the camels being studied, identifying four main tick genera - Hyalomma, Amblyomma, Boophilus, and Rhipicephalus. The most common tick genera found were Rhipicephalus at 41.2%, followed by Hyalomma at 32.3%, Amblyomma at 22.1%, and Boophilus at 4.5%.

Table 1: Ticks inducing paralysis.

Animal	Tick Species	Country
Camel Foals	*D. andersoni*	Australia
Foals	*Rhipicephalus everts*	South Africa
Adult Camel	*Rhipicephalus everts*	Africa

Reference: Radiostits et al., [37]

Table 2: Prevalence of tick infestation based on origin.

Woreda	PAs	No. of Examined	No. of Positive (%)	Prevalance	χ^2	P value
Gola Oda	Gara Gafa	120	95	79.2%	0.0643	0.872
	Bareeda Lenca	108	76	70.4%		
	Cophi mi'awa	90	74	82.2%		
	Burqa	66	50	75.8%		
		384	**295**	**76.8%**		

Table 3: Prevalence of tick infestation based on sex and Age categories.

Variables	Categories	No. of Examined	No. of Infested	Prevalance	χ^2	P-value
Sex	Male	150	113	75.30%	3.24	0.058
	Female	234	182	77.80%		
Total		**384**	**295**	**76.80%**		
Age	Young	231	177	76.60%	1.13	0.224
	Adult	153	118	77.10%		
Total		**384**	**295**	**76.80%**		

Table 4: Prevalence of tick infestation based on body condition categories.

Variables	Categories	No. of Examined	No. of Infested	Prevalance	P-value
Body Condition	Good	70	38	54.30%	0.000
	Medium	129	96	74.40%	
	Poor	185	161	87.00%	
Total		**384**	**295**	**76.80%**	

Table 5: Distribution of Camel Ticks Genera In the study Area.

Tick Genera	No of Tick	Relative Prevalance
Rhipicephalus	1295	41.2%
Hyalomma	1016	32.3%
Amblyomma	694	22.1%
Boophilus	140	4.5%
Total	3145	100%

Discussion

Camels play a crucial and diverse role in the arid regions of Ethiopia, serving as transportation animals and sources of milk and meat for herders. Out of 384 camels examined, 295 (76.8%) were found to be infested with ixodid ticks. 50 camels from Burqa, 76 from Bareda Lenca, 74 from cophi mi'awa, and 95 from Gara Gafa were infested with ticks at rates of 75.8%, 70.4%, 82.2%, and 79.2% respectively. The study indicated that there was no statistically significant correlation between the prevalence of tick infestation in camels and their living areas (PAs), consistent with previous research by Ahmed and Abebe [3], Mohammed et al. [29], and Dinka [16], but contradicting findings by Rahmeto et al. [38] and Ayele and Mohammed [6]. This lack of correlation may be due to the similar climatic conditions across the PAs, as environmental factors like temperature and humidity influence tick survival.

The results of this study are consistent with the research conducted by Ahmed and Abebe [3] in the Jijiga district, Mohammed et al. [29] in the East and West Hararghe zones, and Dinka [16] in Dire Dawa. However, they contradict the findings of Rahmeto et al. [38] in Jijiga and Ayele and Mohammed [6] in Dire Dawa, which suggest a connection between tick infestation rates and camel habitats. This link is believed to be influenced by climate factors affecting tick survival, as noted by Morel [31], with temperature and relative humidity being crucial ecological determinants of tick presence in a given habitat. The absence of a correlation in this study may be due to the similar climatic conditions prevailing across the different Pastoral Areas (PAs).

The study found that there was no statistically significant difference (p>0.05) in the rates of hard tick infestation between male and female camels. However, the proportion of tick species in female camels (77.8%) was slightly higher than in male camels (75.3%), a result consistent with previous findings by Ahmed and Abebe [3], Mohammed et al, [29], Ayele and Mohammed [6] in Ethiopia, Mohsen et al. [30] in Iran, and Maha et al. [23] in Sudan. This difference may be due to the fact that female camels are often found near their homes for milk production and grazing areas, which provide easy access for ticks, while male camels are mainly used for transportation and are more mobile, making them less susceptible to tick infestation, between adult and young camels, with similar prevalence rates observed in both age groups (77.1% in adults and 76.6% in young camels), consistent with the findings of Ahmed and Abebe [3], Ayele and Mohammed [6].

The study did not find a significant difference (p>0.05) in the rates of hard tick infestation between male and female camels, although the proportion of tick species in female camels (77.8%) was slightly higher than in male camels (75.3%). This result aligns with previous research conducted by Ahmed and Abebe [3], Mohammed et al. [29], Ayele and Mohammed [6] in Ethiopia, Mohsen et al. [30] in Iran, and Maha et al. [23] in Sudan. The discrepancy in infestation rates between genders may be due to female camels being more stationary near their homes for milk production and grazing, making them more accessible to ticks, while male camels are typically used for transportation and are more mobile, reducing their susceptibility to tick infestation. Similarly, there was no significant difference in tick prevalence between adult and young camels, with similar rates observed in both groups (77.1% in adults and 76.6% in young camels), consistent with the findings of Ahmed and Abebe (2018) and Ayele and Mohammed [6].

The study also identified a statistically significant association (p<0.05) between the rate of tick infestation and the body condition of the camels. Camels with poor Body Condition Scores (BCS) had the highest tick infestation rate (87.00%) (p=0.000), followed by camels with medium BCS (74.4%) (p=0.000), while camels with good BCS had the lowest infestation rate (54.3%). The higher prevalence of ticks in poorly conditioned camels may be attributed to their unkempt hair coat, which facilitates tick attachment to the skin. Additionally, the overall prevalence of tick burden did not exhibit a significant difference (p>0.05).

In this study, a total of 3145 ticks were collected, representing four different genera: Rhipicephalus, Hyalomma, Ambylomma, and Boophilus. This finding is consistent with previous studies by Mohammed et al. [29], Ahmed and Abebe [3], and Ayele and Mohammed [6] who studied camel ticks in various regions of Ethiopia such as East and West Hararghe Zones, Jigjiga, and Dire Dawa. The presence of similar tick genera across these regions is likely due to the unrestricted movement of camels between these neighboring areas.

Rhipicephalus was identified as the most prevalent tick genus infesting camels in this study, with a relative prevalence of 41.2%. This aligns with the findings of Ayele and Mohammed [6] and Ayana [5] who also reported similar prevalence rates of 46.8%.

Hyalomma was the second most predominant tick genus infesting camels in the study area, with a relative prevalence of 32.3%. This result is somewhat in agreement with the prevalence rates reported by Ahmed and Abebe [3] and Ayele and Mohammed [6], which were 34.6% and 26.8% respectively. This contradicts the findings of Dinka et al. [16], Eyeruselam [18], Bekele [8], and Zeleke and Bekele [54] who reported lower prevalence rates. The difference in prevalence rates could be attributed to varying management practices, agro-ecological conditions, and geographical factors. It's worth noting that Hyalomma ticks have a preference for camels as their hosts

Ambylomma was the third most prevalent tick genus in the study area, representing 22.1% of the total ticks collected. This result is consistent with the findings of Ahmed and Abebe [3] at 22.5%, Ayele and Mohammed (2013) at 11.35%, Eyeruselam [18] at 13.6%, and Bekele [54] at 15.0%. However, it contrasts with the findings of Zeleke and Bekele [54] and Abeba [2] who reported lower prevalence rates. The differences observed may be due to the use of acaricides and varied management practices in different regions. The long mouthparts of Ambylomma ticks are particularly significant in causing udder damage and pose a risk factor for mastitis in camels.

Boophilus was the least abundant genus in the study areas, accounting for 4.5% of the total ticks collected. This lower abundance may be related to the fact that Boophilus, as mentioned by Morel [32], is not very abundant in Ethiopia despite being collected. Boophilus ticks are commonly found in wetter highlands and sub-highlands that receive over 800 mm of rainfall annually, It is noteworthy that Boophilus is a vector for transmitting diseases like Babesiosis and Anaplasmosis [9].

Conclusion and Recommendation

Exodid ticks are widely known for causing significant economic losses by transmitting diseases and reducing livestock output and efficiency. This research reveals a high prevalence (76.8%) of hard tick infestation in camels. Factors like gender, age, origin, and body condition score were examined, with only body condition score showing a statistically significant correlation. The camel ticks identified in randomly selected Pastoral Areas (PAs) of Gola Oda woreda encompass four genera, with Rhipicephalus being the most prevalent and Boophilus the least abundant.

- Based on the study findings, the following recommendations are proposed:Increase awareness among livestock owners regarding the impact of ticks and other external parasites on the health and productivity of their camels.
- Implement an effective tick control strategy in the study area.
- Allocate a yearly budget for the purchase of chemical sprays and spraying equipment by the government or relevant authorities.
- Conduct further comprehensive research on the distribution of ticks in different climatic conditions (seasons) and the diseases they transmit.

Author Statements

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