Analysis of Livestock Tick Distribution and Host Preferences Based on Sex Ratio in Tehran Province

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Article

Analysis of Livestock Tick Distribution and Host Preferences Based on Sex Ratio in Tehran Province

Running title: Livestock Ticks of Tehran, Northern Iran

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Highlights

- Ticks are one of the most dominant ectoparasites of vertebrates and are classified as arthropods. They transmit various pathogens, including bacteria, viruses, and parasites, to both humans and animals, in Iran and globally. Given that sex ratio factors can influence the epidemiology of vector-borne diseases, this study aimed to identify and determine the sex ratio of ticks and their host types (camels, sheep, cattle, dogs, chickens, and pigeons) in different areas of Tehran province.
- This descriptive cross-sectional study collected samples from different animal body parts across four seasons in 2019, involving 20 villages. A total of 685 hard ticks and 121 soft ticks were collected from 1623 livestock and poultry. The sex segregation among all caught ticks revealed that 42.01% were male, and 57.99% were female. Notably, in both mountain and plain environments, the Rhipicephalus sanguineus species of hard ticks exhibited the highest sex ratio. The majority of ticks were collected from sheep hosts (60.04%), whereas the lowest tick infestation was observed in cattle hosts (0.62%).

Abstract: Ticks are one of the most dominant forced ectoparasites of vertebrates, belonging to the arthropods, which transmit pathogens such as bacteria, viruses, and parasites to humans and animals in Iran and worldwide. Given that, sex ratio factors can affect the epidemiology of vector-borne diseases, this study aimed to identify and determine the ticks' sex ratio and host type (camels, sheep, cattle, dogs, chickens, and pigeons) in different areas of Tehran province. This descriptive cross-sectional study took samples from different animal body parts in four seasons from 20 villages in 2019, in which 685 hard ticks and 121 soft ticks were caught from 1623 studied livestock and poultry. Regarding sex segregation among all caught ticks, 42.01% were male, and 57.99% were female. It is noteworthy that in both mountain and plain environments, *R. sanguineus* species of hard ticks had the most elevated sex ratio. Most ticks were collected from sheep hosts with 60.04% and the lowest from cattle hosts with 0.62% in tick infestation.

Keywords: host identification; tick distribution; epidemiology; veterinary parasitology; tick-borne diseases

Introduction

Generally, ticks are divided into two large families, Ixodidae (hard ticks) and Argasidae (soft ticks) with various species and genera, are among the most critical obligate ectoparasites of animals, especially livestock and poultry [1]. These blood-sucking ectoparasites as pathogenic vectors transmit bacteria, viruses, and protists to hosts, including animals and humans. These pathogens cause

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various diseases (e.g., bacterial diseases (Q fever, Lyme disease, borreliosis, relapsing fever, and borreliosis), fungal diseases (dermatophilosis), protozoal diseases (babesiosis and theileriosis), and rickettsial diseases (ehrlichiosis, Brazilian spotted fever, anaplasmosis, and Rocky Mountain spotted fever) [2,3]. Since sex ratio is a critical parameter determining the status and dynamics of animal populations, studies on sex ratio are vital for understanding the biology of populations and the biology of pathogens. Accordingly, arthropod vectors (e.g., ticks) sex ratio could play different roles in pathogen transmission [4,5].

Although ticks have been known since time immemorial, their importance in causing livestock troubles initiated in the mid-19th century; due to the world population increase and the nutritional needs, the number of livestock through the industry has increased rapidly. At the same time, concerns and issues related to ticks emerged [6]. In 1814, piroplasmosis was diagnosed in cattle in the United States, and in 1821 it was discovered that the disease was transmitted to cattle by the ticks' bite called *Boophilus annulatus* [7]. In 1971, Mazloum in Iran conducted studies on the geographical distribution, seasonal activity, preferred ticks hosts, and diseases transmitted to livestock and humans [8]. Pourmand et al. have also conducted a study to determine the frequency and species diversity of hard ticks and their sex ratio in equids in Sardasht suburb, West Azerbaijan Province, Iran. Their results indicate the presence of 85.48% male and 14.51% female ticks with the highest frequency of *Hyalomma anatolicum* (67.74%), *H. marginatum* (8.01%), *Rhipicephalus bursa* (21.94%), and *Dermacentor marginatus* (2.29%), respectively [9]. Therefore, considering that tick bites are a manner of transmitting the disease to livestock and poultry, it seems that identifying the dominant ticks by host and sex ratio of ticks can be a practical way to oppose ticks and prevent transmitted diseases by them stop economic failures due to livestock losses. This study aimed to determine the sex and identify ticks in different hosts, including camels, sheep, cattle, dogs, chickens, and pigeons in Tehran province during 2019.

Materials and Methods

Geographical Area

This study was performed in 20 selected villages of Tehran province with an area of about 185.956 square kilometers, located between 34 to 5.36 degrees north latitude and 50 to 53 degrees east longitude.

Sampling Size and Method

The sample size was determined using the [10] procedure, in which (d=0/045, p=0 /3, (1-p) = 0/7). Accordingly, 685 hard ticks and 121 soft ticks were collected from 1623 livestock and poultry.

$$n_0 = \frac{Z^2_{1-\alpha/2} p(1-p)}{d^2}$$

Sample Collection and Identification

The feeding ticks on the animal body were separated from different parts such as earlobes, groin, tail base, and abdomen and transferred to particular cans using a pence. Then the characteristics of the animal (age, sex, livestock owner, and livestock code), village name, and date of tick collection, collector name, and the number of caught ticks were recorded on the can and transferred to a unique flask to maintain the humidity and temperature required by the ticks (Figure 1). The ticks were then transferred to the laboratory for diagnosis and placed under a loop (stereomicroscope) to identify the sex and species using the valid diagnostic keys of the world and the region [11].

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Figure 1. Collection of ticks from hosts and identifications using loop (stereomicroscope) .

Results

Identification and Distribution of Livestock Ticks by Sex

This study gathered 685 hard ticks and 121 soft ticks from a total of 1623 domestic animals, including camels, sheep, cows, dogs, chickens, and pigeons infected with ticks. Regarding sex segregation among all caught ticks, the results showed that 42.01% of ticks were male, 57.99% female, and 15.01% soft ticks (Figure 2). In addition, among 685 hard-caught ticks (44.37%), 304 were male, and (55.62%) 381 were female. In both mountain and plain climates, *R. sanguineus* has the highest sex ratio of hard ticks (Table 1).

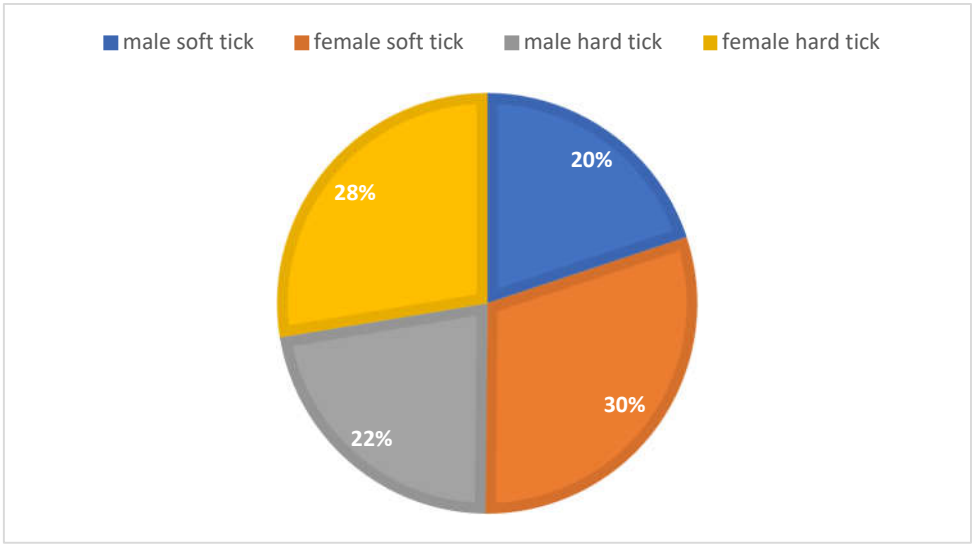

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Figure 2. Percentage of the relative frequency of caught ticks by sex in Tehran province, 2019.

Table 1. Identification and determination of the distribution of hard ticks by sex, Tehran province, 2019.

Genera	*Mountainous*		*Plain*	
	♂	♀	♂	♀
R. sanguineus	74	102	64	58
Hy. marginatum	0	0	91	61
Hy. asiaticum	0	0	26	41
Hy. dromedarii	0	0	17	32
Hae. sulcata	0	47	0	0
Hy. anatolicum	0	0	15	6
Hae. inermis	12	12	0	0
Hae. erinacei	0	9	0	0
R. bursa	5	4	0	0
Hy. detritum	0	0	0	6
B. annulatus	0	3	0	0
Total	**91**	**177**	**213**	**204**

Identify and Determine the Distribution of Ticks by Host Type

Concerning tick-infested hosts, most ticks were collected from sheep with 60.04% and the lowest from cattle with 0.62%. Among the species of caught ticks, in the family of hard ticks, the genus *Boophilus* was collected only from the cattle, the genus *Haemaphysalis* from the sheep and goats, and the genera of *Ripisfalus* and *Hyalomma* were collected from all hosts (except pigeons, chickens, and corral wall). In the soft tick's family, the genus *Ornithodoros* was collected only from the cage wall, and the genus *Argas* was collected from both pigeon and chicken. Unlike soft ticks, no soft ticks were caught from cattle, sheep, goats, camels, and dogs. (Table 2). The frequency of caught tick species by host type is such that in cattle, two species of *Hy. Marginatum* and *B. annulatus* were found in small quantities. In sheep, *R. sanguineus* with 242 numerals had the highest, and *R. bursa* with 5 numerals had the lowest amount. *R. sanguineus* is found with the highest accumulation on the body of goats. In camels, the species *Hy. Marginatum* had the highest, and *R. sanguineus* had the lowest frequency. In dogs, only *R. sanguineus* with 19 numbers was found. In pigeons, only *A. reflexus* of the genus *Argas* has been collected. *A. persicus* was collected in significant abundance from the chicken body, and *O. lahorensis* was found only from the corral wall (Table 3).

Table 2. Frequency of caught ticks by host type, Tehran province, 2019.

Host	*Ticks genera*					
	Rhipicephalus	*Hyalomma*	*Argas*	*Haemaphysalis*	*Ornithodoros*	*Boophilus*
Cattle	0	2	0	0	0	3
Sheep	242	174	0	68	0	0
Goats	42	8	0	12	0	0
Camels	4	111	0	0	0	0
Dogs	19	0	0	0	0	0
Pigeons	0	0	9	0	0	0
Chickens	0	0	93	0	0	0
Corral Wall	0	0	0	0	19	0
Total	**307**	**295**	**102**	**80**	**19**	**3**

Table 3. Intensity of infested animals by different climates, Tehran province, 2019.

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	Host							*Corral Wall*
Ticks' genera	**Cattle**	**Sheep**	**Goats**	**Camels**	**Dogs**	**Pigeons**	**Chickens**	
R. sanguineus	0	237	38	4	19	0	0	0
Hy. marginatum	2	84	0	66	0	0	0	0
A. persicus	0	0	0	0	0	0	93	0
Hy. asiaticum	0	61	0	6	0	0	0	0
Hy. dromedarii	0	17	8	24	0	0	0	0
Hae. sulcata	0	44	3	0	0	0	0	0
Hy. anatolicum	0	12	0	9	0	0	0	0
O. lahorensis	0	0	0	0	0	0	0	19
Hae. inermis	0	18	6	0	0	0	0	0
Hae. erinacei	0	6	3	0	0	0	0	0
A. reflexus	0	0	0	0	0	9	0	0
R. bursa	0	5	4	0	0	0	0	0
Hy. detritum	0	0	0	6	0	0	0	0
B. annulatus	3	0	0	0	0	0	0	0
806 Total:	**5**	**484**	**62**	**115**	**19**	**9**	**93**	**19**

Discussion

The current study results show that sex ratios observed in ticks differ among genera and even among host populations. Life-history aspects probably play an essential role, but survival analyses under natural conditions are lacking in practically all tick genera, which are crucial to elucidate general patterns. Prospective molecular methods will provide new routes to determine the vast spectrum of possible performers that affects sex ratios. Previous studies demonstrated that sex ratios could depend on the season and area of collection. Also, in arthropods (e.g., ticks), sex ratios could be skewed towards females by reproductive parasites that appertain to this gender for their transmission (transovarial) [12,13]. Our results showed that the highest rate of infected livestock with ticks related to sheep with 60.04%, and the lowest rate related to cattle with 0.62% because most studied livestock was sheep. The study in Ghaemshahr city demonstrated that the highest rate of infected livestock with ticks was observed in sheep with 28.3% and the lowest with 20% in cattle, which is compatible with our results [14]. In addition, the dominant fauna species was *Rhipicephalus Sanguineus*, which was consistent with the results of many previous researchers [15,16]. Therefore, in conclusion, the genus and species of dominant ticks in each region are diverse, and the geographical zone and climatic conditions of the area regulate the species and even the sex of active ticks in that province. Therefore, due to the high contamination of sheep, it is necessary that the authorities veterinary personnel and ranchers in the control and control programs against external livestock parasites (mites). At least twice a year (with a maximum interval of 30 days), in addition to corral pesticide spraying, bathing the animals in the anti-tick bath.

Contributions of the Authors: E.A. designed and collected the ticks, and identified tick species, recorded geographic coordinates and area information, wrote the manuscript, and confirmed and sent the articles.

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