Assessing the Influence of Seasonal and Climatic Variations on Livestock Tick Incidence in Tehran Province, Iran

Ebrahim Abbasi

Submitted to: JMIRx Bio
on: December 02, 2024

Table of Contents

Assessing the Influence of Seasonal and Climatic Variations on Livestock Tick Incidence in Tehran Province, Iran

Ebrahim Abbasi[1]

[1]Shiraz Medical Sciences pars street shiraz IR

Corresponding Author:
Ebrahim Abbasi
Shiraz Medical Sciences
pars street
Shiraz Medical Sciences
pars street
shiraz
IR

Abstract

Background: Ticks are well-known ectoparasites of domestic animals, causing significant economic losses and playing a crucial role in the transmission of pathogens within the livestock industry worldwide, including in Iran. Understanding the distribution and diversity of ticks is essential for effective control strategies, especially in regions like Tehran Province, where livestock plays a vital role in the economy.

Objective: This study aimed to determine the frequency and distribution of livestock ticks across different seasons and climatic zones in Tehran Province.

Methods: In 2019, 1,623 livestock and poultry, including chickens, sheep, camels, cows, pigeons, and dogs, infected with ticks were examined. A total of 806 ticks were collected, comprising 121 soft ticks and 685 hard ticks. Tick species were identified and categorized based on their occurrence in mountainous and plain climatic regions.

Results: Fourteen tick species were identified, including: Soft ticks: Argas persicus, Argas reflexus, Ornithodoros lahorensis. Hard ticks: Boophilus annulatus (Rhipicephalus (Boophilus) annulatus), Hyalomma asiaticum, Hyalomma marginatum, Hyalomma dromedary, Hyalomma anatolicum, Hyalomma detritus, Haemaphysalis sulcata, Haemaphysalis echinacea, Haemaphysalis inermis, Rhipicephalus bursa, and Rhipicephalus sanguineus. The most prevalent species was R. sanguineus (36.97%), while the least frequent was R. (B.) annulatus (0.37%). Other species with notable frequencies included A. persicus (11.53%) and Hy. marginatum (18.85%). In terms of distribution, 44.78% of ticks were collected from mountainous regions, while 55.21% were found in plain regions, indicating a higher prevalence in plains.

Conclusions: The study highlights the significant diversity and abundance of both soft and hard ticks in poultry and livestock across various regions of Tehran Province. These findings emphasize the need for targeted tick control measures, considering the differences in tick distribution between mountainous and plain climates. Clinical Trial: Not applicable.

(JMIR Preprints 02/12/2024:69542)
DOI: https://doi.org/10.2196/preprints.69542

Preprint Settings

1) Would you like to publish your submitted manuscript as preprint?

✓ **Please make my preprint PDF available to anyone at any time (recommended).**
Please make my preprint PDF available only to logged-in users; I understand that my title and abstract will remain visible to all users.
Only make the preprint title and abstract visible.
No, I do not wish to publish my submitted manuscript as a preprint.

2) If accepted for publication in a JMIR journal, would you like the PDF to be visible to the public?

✓ **Yes, please make my accepted manuscript PDF available to anyone at any time (Recommended).**
Yes, but please make my accepted manuscript PDF available only to logged-in users; I understand that the title and abstract will remain v

Yes, but only make the title and abstract visible (see Important note, above). I understand that if I later pay to participate in <a href="http

Original Manuscript

Assessing the Influence of Seasonal and Climatic Variations on Livestock Tick Incidence in Tehran Province, Iran

Ebrahim Abbasi[1]*

[1]*Department of Medical Entomology and Vector Control, School of Health, Shiraz University of Medical Sciences, Shiraz, Iran.*

* abbasie.ebrahim@gmail.com, e_abbasie@sums.ac.ir

Running title: Livestock ticks of Tehran, northern Iran

Abstract

Background: Ticks are well-known ectoparasites of domestic animals, causing significant economic losses and playing a crucial role in the transmission of pathogens within the livestock industry worldwide, including in Iran. Understanding the distribution and diversity of ticks is essential for effective control strategies, especially in regions like Tehran Province, where livestock plays a vital role in the economy.

Objective: This study aimed to determine the frequency and distribution of livestock ticks across different seasons and climatic zones in Tehran Province.

Methods: In 2019, 1,623 livestock and poultry, including chickens, sheep, camels, cows, pigeons, and dogs, infected with ticks were examined. A total of 806 ticks were collected, comprising 121 soft ticks and 685 hard ticks. Tick species were identified and categorized based on their occurrence in mountainous and plain climatic regions.

Results: Fourteen tick species were identified, including: Soft ticks: *Argas persicus, Argas reflexus, Ornithodoros lahorensis*. Hard ticks: *Boophilus annulatus (Rhipicephalus (Boophilus) annulatus), Hyalomma asiaticum, Hyalomma marginatum, Hyalomma dromedary, Hyalomma anatolicum, Hyalomma detritus, Haemaphysalis sulcata, Haemaphysalis echinacea, Haemaphysalis inermis, Rhipicephalus bursa, and Rhipicephalus sanguineus.* The most prevalent species was *R. sanguineus* (36.97%), while the least frequent was *R. (B.) annulatus* (0.37%). Other species with notable frequencies included *A. persicus* (11.53%) and *Hy. marginatum* (18.85%). In terms of distribution, 44.78% of ticks were collected from mountainous regions, while 55.21% were found in plain regions, indicating a higher prevalence in plains.

Conclusions: The study highlights the significant diversity and abundance of both soft and hard ticks in poultry and livestock across various regions of Tehran Province. These findings emphasize the need for targeted tick control measures, considering the differences in tick distribution between mountainous and plain climates.

Keywords: Impact of Climatic, Seasonal Change, Frequency, Livestock, Ticks, Tehran

Introduction

Ticks are of outstanding medical and veterinary importance and transmit severe and dangerous diseases to

humans and animals [1]. In humans, most spirochetes and diseases caused by rickettsia are transmitted by ticks. In addition, these arthropods cause severe diseases such as paralysis, encephalitis, and tularemia [2]. Moreover, ticks cause livestock financial losses worldwide and in Iran in the way that the annual impairment caused by ticks is estimated at 13.9 to 18.7 billion US$ [3].

The presence of ticks on livestock causes localized lesions at the bite site and systemic lesions, leading to death due to anemia and paralysis due to ticks transmitting various diseases such as theileriosis and babesiosis [4](4). On the other hand, global climate change has significantly impacted the stability and distribution of lifestyles [5], and climate conditions are the most critical factor determining tick distribution[6]. The tick-borne diseases associated with wildlife and climate change favor the re-emergence of diseases and the possible risk of the emergence of new ones [7].

Although the parasitic fauna of Argasidae and Ixodidae ticks and some of their ecological characteristics have been studied in a few areas of Iran [8], various species in all regions of Iran in general and Tehran Province in particular and especially the seasonal activity are not thoroughly studied. Tehran Province is located between the mountainous and the plain [9]regions (9). Three factors, humid westerly winds, the province's extent, and the Alborz Mountain range, play an essential role in Tehran's climate. The Alborz Mountain range has tempered the climate of Tehran. It is mountainous, temperate in the north, and semi-arid in the lowlands of Tehran, respectively. Tehran Province features a diverse geography, encompassing mountainous and plain areas with distinct climates. In the mountainous region, such as Shemiranat, the average annual temperature ranges from 10 °C to 12 °C, with increased precipitation of 350 to 400 mm annually. Winters are cold, with substantial snowfall, while summers are mild. Conversely, the plain areas like Varamin have hotter conditions, averaging from 18 °C to 20 °C annually, with lower rainfall of 150 to 250 mm. These plains experience hot summers and milder winters, characterized by a semi-arid climate[10, 11].

The present study was conducted to determine the seasonal and climate frequency of tick species in Tehran Province on the body surface of poultry and livestock involving chickens, camels, cattle, dogs, pigeons, and sheep in different areas. The importance and position of tick control in this region will become more evident when we know the distribution of ticks, their location, and presence in each region, and the epidemiological situation can be determined. In Tehran Province, so far, not much research has been done on the climatic and seasonal distribution of different species of ticks.

Also, the published information about livestock and poultry infested with ticks in this area is not complete, so the purpose of this study is to provide an accurate scientific report of the situation of livestock and poultry infested with hard and soft ticks during different climates and seasons of the year, this information can be used in macro planning to combat foreign parasites.

Materials and Methods

Geographical area

The study was conducted in two different environments: plains and mountains within 20 selected villages in

Tehran Province which were between "34 to 36.5 ′N and 50 to 53 ′E".

Sampling

The sample size of this study was calculated using the formula below [12], and approximately 800 ticks were caught (p = 0.3, d = 0.045, (1-p) = 0.7).

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

Study area

The study was performed in two separate climatic zones, including six mountainous villages and 14 plain villages. After collecting geographical and ecological information, 1623 livestock were selected[12]. Using a cross-sectional study design, the distribution of ticks was studied in different study areas from spring to the end of winter of 2019. Ticks were collected using curve pence from the host body (animal's earlobes, groin, tail base, and back, and poultry's underarms, groin, and abdomen). To identify the collected ticks' genus and species, valid diagnostic keys were used [13]. Due to the distribution of ticks in the study area, the prepared maps and identification of infected carriers, climate, and host animals of these tick species were shown, and an understanding of the existing situation in the province was offered[14-18].

Results

Determining the frequency of livestock ticks by climate type

In this study, 1623 domestic animals (infested with ticks), including chickens, camels, cattle, dogs, pigeons, and sheep, were studied. Of these, 685 and 121 of them were detected as hard ticks and soft ticks, respectively. In mountain and plain climates, the distribution of collected ticks indicates that out of 806 collected ticks, 361 (44.78%) belonged to the mountainous region, and 445 (55.21%) belonged to the plain region (Figure 1).

In the mountainous region, the genus *Rhipicephalus*, with 51.24% (185), has the highest, and the genera *Hyalomma* and *Ornithodoros* without distribution have the lowest frequency. In the plain region, the *Hyalomma* genus, with 66.29% (295), has the highest, and *Haemaphysalis* and *Boophilus* genera have the lowest percentage of distribution (Table 1).

Argas persicus from *Argas* and *Rhipicephalus bursa*, *Rhipicephalus sanguineus* from *Rhipicephalus*, and all species of *Boophilus* and *Haemaphysalis* genera have been found in the mountain regions of Tehran. Among the ticks found in the mountainous region, *Rhipicephalus sanguineus*, with 176 (48.75%), had the highest. In comparison, *Boophilus annulatus* with 3 (0.83%) had the lowest frequency (*species, including Hy. marginatum*, *Hy. asiaticum*, *Hy. dromedarii*, *Hy. anatolicum*, *O. lahorensis*, *A. reflexus* and *Hy. detritum* were not found in mountainous areas). All *Ornithodoros*, *Hyalomma*, *A. reflexus* and *R. sanguineus* have been collected from the plain regions. Among the tick species found in the plain's region, *Hy. marginatum* with 152 (34.15%) had the highest frequency and *Hy. detritum* with 6 (1.34%) has the lowest frequency (*A. persicus*, *Hae. sulcata*, *Hae. inermis*, *Hae. erinacei*, *R. bursa*, and *Rhipicephalus (Boophilus) annulatus (R (B.) annulatus)* were not found in the plain region) (Table 2).

The results of livestock infection in different ecological areas showed that 28.04% and 71.96% of studied animals belonged to the mountainous and plain regions, respectively. Of the 806 ticks collected, 361 (44.78%) belonged to the mountainous, and 445 (55.21%) belonged to the plain regions (Table 3).

When analyzing the data, it was found that domestic animals had the highest rate of tick infection in spring, while the lowest rate of infection was observed in winter. It indicates a seasonal variation in tick distribution and infection rates among domestic animals. In the spring, all genera (except the genera *Boophilus*) were found. The genera *Rhipicephalus* and *Hyalomma* are distributed in the summer. In autumn, the genus *Hyalomma* is the most abundant, and in winter, the species *A. persicus* belongs to the family of soft ticks and has a high abundance (Table 4). The frequency of all six ticks (4 hard ticks and two soft ticks) in different seasons of the year is described below.

Seasonal activity and fauna of *Rhipicephalus* (hard tick)

In this study, 307 ticks of the genus *Rhipicephalus* were caught, which was 30.08% of the total samples collected (the highest frequency among the genera). *R. sanguineus* of this genus has been seasonally distributed in all seasons, while *R. bursa* has been caught only in spring and winter (Figure 2).

Seasonal activity and fauna of *Hyalomma* (hard tick)

The genus *Hyalomma*, with 289 ticks, was the second most abundant genus, accounting for 35.85% of the total samples. *Hy. marginatum*, *Hy. asiaticum*, and *Hy. dromedarii* has been caught in all seasons, but *Hy. anatolicum* and *Hy. detritum* has been caught in spring and winter (Figure 3 and 4).

Seasonal activity and fauna of *Haemaphysalis* (hard ticks)

The genus *Haemaphysalis* is the third genus of the hard tick family detected in this study, and it has three species of *Hae. sulcata*, *Hae. inermis* and *Hae. erinacei* gathering from 80 ticks with a frequency of 9.92%. *Hae. sulcata* can be found in all seasons except for autumn, *Hae. inermis* in spring and summer, *and Hae. erinacei* was caught only in spring (Figure 5).

Seasonal activity and fauna of *Rhipicephalus (Boophilus)* (hard tick)

In this study, *Boophilus* was caught only in summer with one species (*Rhipicephalus (Boophilus) annulatus (R (B.) annulatus*) with an abundance of 3 ticks (Figure. 6).

Seasonal activity and fauna of *Argas* and *Ornithodoros* (soft ticks)

In this study, 121 (15.01%) ticks belonging to the soft tick family were caught, of which 102 (84.29%) included *Argas* with two species, *A. persicus* and *A. reflexus*, and the genus *Ornithodoros* with only species *O. lahorensis* contains 19 (15.70%) ticks. Species *of A. persicus was caught in all seasons except for summer, A. reflexus in spring and autumn, and O. lahorensis in all seasons* except for winter (Figures 7, 8, and 9).

Discussion

This study is the only codified and comprehensive study on Ixodidae and Argasidae ticks and their climatic and seasonal activities during 2019 in Tehran Province. Ixodes genus was not found in our study because this genus is more distributed in the country's northern provinces such as Gilan, Mazandaran, and Golestan Provinces and two professional stereo microscopes were used to identify tick species: the Leica S9i and the

Zeiss Stemi 508. The Leica S9i has 10x to 60x magnification and includes a 10MP camera, while the Zeiss Stemi 508 offers 8x to 50x magnification with superior optical quality. Both tools are essential for the detailed investigation of tick morphology in entomological research [19].

A study in Pakistan confirmed the dominance of tick species of *Rhipicephalus (Boophilus) annulatus* and *Hyalomma anatolicum*, also prevalent in Tehran Province, particularly impacting sheep and cattle. In contrast, a study done in Turkey highlighted that *Ixodes ricinus* is predominantly found in humid regions, which differs from Tehran's dry climate. Studies from India are also aligned with Tehran's findings, showing *Rhipicephalus sanguineus* as the most common species. Conversely, Japan reported *Haemaphysalis longicornis* as the most frequent species, influenced by temperate climates. Southern Europe exhibits some similarities with Tehran, particularly regarding *Rhipicephalus sanguineus*; however, it includes higher *Ixodes ricinus* prevalence. Northern Europe shows a dominance of *Ixodes ricinus* due to temperate climates, differing from Tehran's dry conditions. In North Africa, tick species like *Hyalomma anatolicum* can be found which aligns with Tehran's findings, while Sub-Saharan Africa presents contrasting species like *Amblyomma variegatum*, thriving in humid climates. Overall, the analysis emphasizes how climate and ecology influence tick species composition and host preferences across regions[20-26].

Furthermore, this genus is more distributed in the cold and wet seasons of the year. In our study, different cities in Tehran Province did not have high humidity compared to the values of the northern provinces. Therefore, it is assumed that high humidity is a limiting factor in the distribution of this tick in our study area. In a study in Golestan Province, six genera and 15 species of ticks, including soft and hard ticks, were reported [27], considerably similar to our study conducted in Tehran Province.

This may be due to the climatic similarities of the two provinces and the proximity and parallelism of research. *Argas persicus* species of soft ticks' family have been caught in Shemiranat city in Tehran Province, which has a mountainous climate with a frequency of 11.53%. *Argus persicus* is caught in all seasons except for summer. Its highest frequency was observed in autumn, which is consistent with studies conducted in Sanandaj, Boyer-Ahmad, and Bijar cities of Kurdistan Province [28-30].

Rhipicephalus sanguineus was the most abundant among the caught ticks in Tehran Province. This species has been caught in Tehran, Islamshahr, Shemiranat, Shahreri, Pakdasht, and Varamin cities from both plain and mountain climates, which is consistent with other studies carried out in Ghaemshahr, Mazandaran Province [31]. In general, the results of this study agree with the studies of other researchers due to the similarity of climatic conditions. However, slight differences were observed between the results, which can be related to climatic diversity and the susceptibility of different breeds of livestock and poultry.

Conclusions

The distribution of collected ticks (in mountain and plain climates) indicated that out of 806 collected ticks, 44.78% and 55.21% belonged to the mountainous and plain regions, respectively. This study demonstrated significant abundance and diversity of Ixodidae and Argasidae ticks in poultry and livestock in different places of Tehran Province.

Acknowledgments

The authors would like to thank the Veterinary Office of Tehran Province and the research vice-chancellor of Shiraz University of Medical Sciences for their cooperation.

Declaration

Funding

This study received no grants from commercial, public, or nonprofit entities.

Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

All data obtained from this research are included in the article's main text.

Contributions of the authors

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

Ethical approval and consent to participate

Not applicable.

Consent to participate

Not applicable.

Consent to publication

The author fully consents to the publication of the article.

References

1. Wikel SK. Ticks and tick-borne infections: complex ecology, agents, and host interactions. Veterinary sciences. 2018;5(2):60.

2. Rochlin I, Toledo A. Emerging tick-borne pathogens of public health importance: a mini-review. Journal of medical microbiology. 2020;69(6):781.

3. Haghi FM, Razmi G, Fakhar M, Mohammadpoor RA. The hard ticks (Ixodidae) fauna of livestock in Sari suburb, Northern Iran. Comparative Clinical Pathology. 2013;22(1):5-8.

4. Hasheminasab SS, Moradi P, Wright I. A four year epidemiological and chemotherapy survey of babesiosis and theileriosis, and tick vectors in sheep, cattle and goats in Dehgolan, Iran. Annals of parasitology. 2018;64(1).

5. Cavicchioli R, Ripple WJ, Timmis KN, Azam F, Bakken LR, Baylis M, et al. Scientists' warning to humanity: microorganisms and climate change. Nature Reviews Microbiology. 2019;17(9):569-86.

6. Rochlin I. Modeling the Asian longhorned tick (Acari: Ixodidae) suitable habitat in North America. Journal of medical entomology. 2019;56(2):384-91.

7. Tsao JI, Hamer SA, Han S, Sidge JL, Hickling GJ. The contribution of wildlife hosts to the rise of ticks and tick-borne diseases in North America. Journal of Medical Entomology. 2021.

8. Hosseini-Chegeni A, Tavakoli M, Telmadarraiy Z. The updated list of ticks (Acari: Ixodidae & Argasidae) occurring in Iran with a key to the identification of species. Systematic and Applied Acarology. 2019;24(11):2133-66.

9. Fathi A, Lee T, Mohebzadeh H. Allocating underground dam sites using remote sensing and GIS case study on the southwestern plain of Tehran Province, Iran. Journal of the Indian Society of Remote Sensing. 2019;47(6):989-1002.

10. Noorisameleh Z, Gough WA, Mirza MMQ. Persistence and spatial–temporal variability of drought severity in Iran. Environmental Science and Pollution Research. 2021;28:48808-22.

11. Sanei A. Novel regional classification of natural and socioeconomic characteristics for the Persian leopard research and conservation programs. Research and Management Practices for Conservation of the Persian Leopard in Iran: Springer; 2020. p. 51-80.

12. Hosseini-Vasoukolaei N, Oshaghi MA, Shayan P, Vatandoost H, Babamahmoudi F, Yaghoobi-Ershadi MR, et al. Anaplasma infection in ticks, livestock and human in Ghaemshahr, Mazandaran Province, Iran. Journal of arthropod-borne diseases. 2014;8(2):204.

13. Jongejan F, Zivkovic D, Pegram R, Tatchell R, Fison T, Latif A, et al. Ticks (Acari: Ixodidae) of the Blue and White Nile ecosystems in the Sudan with particular reference to the Rhipicephalus sanguineus group. Experimental & applied acarology. 1987;3(4):331-46.

14. Camicas J-L, Hervy J-P, Adam F, Morel P. Les tiques du monde (Acarida, Ixodida): nomenclature, stades décrits, hôtes, répartition (espèces décrites avant le 1/01/96)= The ticks of the world (Acarida, Ixodida): nomenclature, described stages, hosts, distribution (including new species described before 1/01/96). Éditions de l'Orstom, Paris. 1998.

15. Estrada-Peña A, Jongejan F. Ticks feeding on humans: a review of records on human-biting Ixodoidea with special reference to pathogen transmission. Experimental & applied acarology. 1999;23:685-715.

16. Jongejan F, UILENBERG G. The global importance of ticks. Parasitology. 2004;129(S1):S3-S14.

17. Keirans JE, Litwak TR. Pictorial key to the adults of hard ticks, family Ixodidae (Ixodida: Ixodoidea), east of the Mississippi River. Journal of medical entomology. 1989;26(5):435-48.

18. Walker AR. Ticks of domestic animals in Africa: a guide to identification of species: Bioscience Reports Edinburgh; 2003.

19. Noori NV, Rahbari S, Bokaei S. The seasonal activity of Rhipicephalus bursa in cattle in Amol (northern Iran). World Applied Sciences Journal. 2012;18(4):590-3.

20. Accorsi A, Schiavetti I, Listorti V, Dellepiane M, Masotti C, Ercolini C, et al. Hard Ticks (Ixodidae) from Wildlife in Liguria, Northwest Italy: Tick Species Diversity and Tick-Host Associations. Insects. 2022;13(2):199.

21. Bournez L, Cangi N, Lancelot R, Pleydell D, Stachurski F, Bouyer J, et al. Parapatric distribution and sexual competition between two tick species, Amblyomma variegatum and A. hebraeum (Acari, Ixodidae), in Mozambique. Parasites & Vectors. 2015;8:1-14.

22. Etiang P, Atim SA, Nkamwesiga J, Nalumenya D, Byaruhanga C, Odongo S, et al. Identification and distribution of Rhipicephalus microplus in selected high-cattle density districts in Uganda: signaling future demand for novel tick control approaches. BMC Veterinary Research. 2024;20(1):119.

23. Etiang P, Musoba A, Nalumenya D, Ndekezi C, Bbira J, Ochwo S, et al. Distribution and prevalence of ixodid tick species (Acari: Ixodidae) infesting cattle in Karamoja region of northeastern Uganda. BMC Veterinary Research. 2024;20(1):50.

24. Melnikova O, Adelshin R, Trushina YN, Yakovchits N, Andaev E. Identification of the Spectrum of Pathogens in Ixodid Ticks from Natural Co-Infection Foci of the Baikal Region. Entomological Review. 2019;99:262-73.

25. Pantchev N, Pluta S, Huisinga E, Nather S, Scheufelen M, Vrhovec MG, et al. Tick-borne diseases (borreliosis, anaplasmosis, babesiosis) in German and Austrian dogs: status quo and review of distribution, transmission, clinical findings, diagnostics and prophylaxis. Parasitology Research. 2015;114(Suppl 1):19-54.

26. Wagner E, Tukhanova N, Shin A, Turebekov N, Shapiyeva Z, Shevtsov A, et al. Incidence of tick-borne spotted fever group Rickettsia species in rodents in two regions in Kazakhstan. Scientific Reports. 2022;12(1):14872.

27. Sofizadeh A, Telmadarraiy Z, Rahnama A, Gorganli-Davaji A, Hosseini-Chegeni A. Hard tick species of livestock and their bioecology in Golestan province, north of Iran. Journal of arthropod-borne diseases. 2014;8(1):108.

28. Yakhchali M, Rostami A, Esmaelzadeh M. Diversity and seasonal distribution of ixodid ticks in the natural habitat of domestic ruminants in north and south of Iran. Revue Méd Vét. 2011;162(5):229-35.

29. Shayeghi M, KHORAM RA, Piazak N. GEOGRAPHICAL DISTRIBUTION OF TICKS (SOFT AND HARD) IN CITY OF BOYERAHMAD (KOHGHHOYEH AND BOYERAHMAD PROVINCE) 2003-2004. 2004.

30. Rafinejad J, Shemshad K, Banafshi O. Epidemiological study on tick-borne (Acari: Argasidae) relapsing fever in Kurdistan Province, Iran, 2000–2004. Florida Entomologist. 2012;95(3):758-63.

31. Nasibeh HV, Zakkyeh T, Hassan V, Reza YEM, Morteza HV, Ali OM. Survey of tick species parasiting domestic ruminants in Ghaemshahr county, Mazandaran province, Iran. Asian pacific Journal of Tropical medicine. 2010;3(10):804-6.

List of Legends

Figure 1. The ratio of caught ticks according to climatic topography, Tehran Province, 2019

Figure 2. Rear view (A) male right and left female ***Rhipicephalus sanguineus*** and (B) male right and left female ***Rhipicephalus bursa*** (Original)

Figure 3. Rear view (A) of male and (B) female ***Hyalomma marginatum*** tick and dorsal view (C) of female and abdominal (D) female ***of Hyalomma detritus*** tick (Original)

Figure 4. Frequency distribution of *Hyalomma* tick's species according to seasonal activity, Tehran Province, 2019

Figure 5. Rear view (A) of right male and left female ***Haemaphysalis sulcata*** and (B) Abdominal view of ***Haemaphysalis erinasei*** (Original)

Figure 6. Back view (A) and abdominal view (B) of female ***Rhipicephalus (Boophilus) annulatus*** (engorge) tick (Original)

Figure 7. Back view (A) and abdominal view (B) of ***Argas persicus*** tick (Original)

Figure 8. Frequency distribution of soft tick's species according to seasonal activity, Tehran Province, 2019

Figure 9. Back view (A) and abdominal view (B) ***Ornithodoros lahorensis*** tick (Original)

Table legends

Table 1. The ratio of caught ticks according to climatic topography, Tehran Province, 2019.

Genera	**Mountainous**		**Plain**	
	Number	**%**	**Number**	**%**
Rhipicephalus	185	60.26	122	39.73
Hyalomma	0	0	295	100
Argas	93	91.17	9	8.82

Haemaphysalis	80	100	0	0
Ornithodoros	0	0	19	100
Rhipicephalus (Boophilus)	3	100	0	0
Total	361	44.78	445	55.21

Table 2. The ratio of caught ticks' species according to climatic topography, Tehran Province, 2019.

Species	Mountainous		Plain	
	Number	%	Number	%
R. sanguineus	176	59.06	122	40.93
Hy. marginatum	0	0	152	100
A. persicus	93	100	0	0
Hy. anatolicum	0	0	21	100
Hy. dromedarii	0	0	49	100
Hy. asiaticum	0	0	67	100
Hae. sulcata	47	100	0	0
O. lahorensis	0	0	19	100
Hae. inermis	24	100	0	0
Hae. erinacei	9	100	0	0
A. reflexus	0	0	9	100
R. bursa	9	100	0	0
Rhipicephalus (Boophilus) annulatus (R (B.) annulatus)	3	100	0	0
Hy. detritum	0	0	6	100
Total	361	44.78	445	55.21

Table 3. Frequency of animals infested by ticks in different climates in Tehran Province during 2019.

Number of collected ticks (%)	Number of infested livestock (%)	Number of studied livestock (%)	Climatic region
361 (44.78%)	97 (42.17%)	628 (38.70%)	Mountainous
445 (55.21%)	133 (57.82%)	995 (61.30%)	Plain
806 (100%)	230 (100%)	1623 (100%)	Total

Table 4. Frequency of caught ticks according to the seasonal activity, Tehran Province in 2019

Species	Seasons

	Spring	Summer	Autumn	Winter	Total	%
R. sanguineus	251	23	18	6	298	36.97
Hy. marginatum	74	53	14	11	152	18.85
A. persicus	34	0	41	18	93	11.53
Hy. asiaticum	33	22	9	3	67	8.31
Hy. dromedarii	11	13	7	18	49	6.07
Hae. sulcata	28	15	0	4	47	5.83
Hy. anatolicum	14	0	0	7	21	2.60
O. lahorensis	12	3	4	0	19	2.35
Hae. erinacei	9	0	0	0	9	1.11
Hae. inermis	12	0	12	0	24	2.97
A. reflexus	3	0	6	0	9	1.11
R. bursa	3	0	0	6	9	1.11
Rhipicephalus (Boophilus) annulatus (R (B.) annulatus)	0	3	0	0	3	0.37
Hy. detritum	2	0	0	4	6	0.74
Total	13 Genera 486	7 Genera 132	8 Genera 111	9 Genera 77	14 Genera 806	100

Figure legends

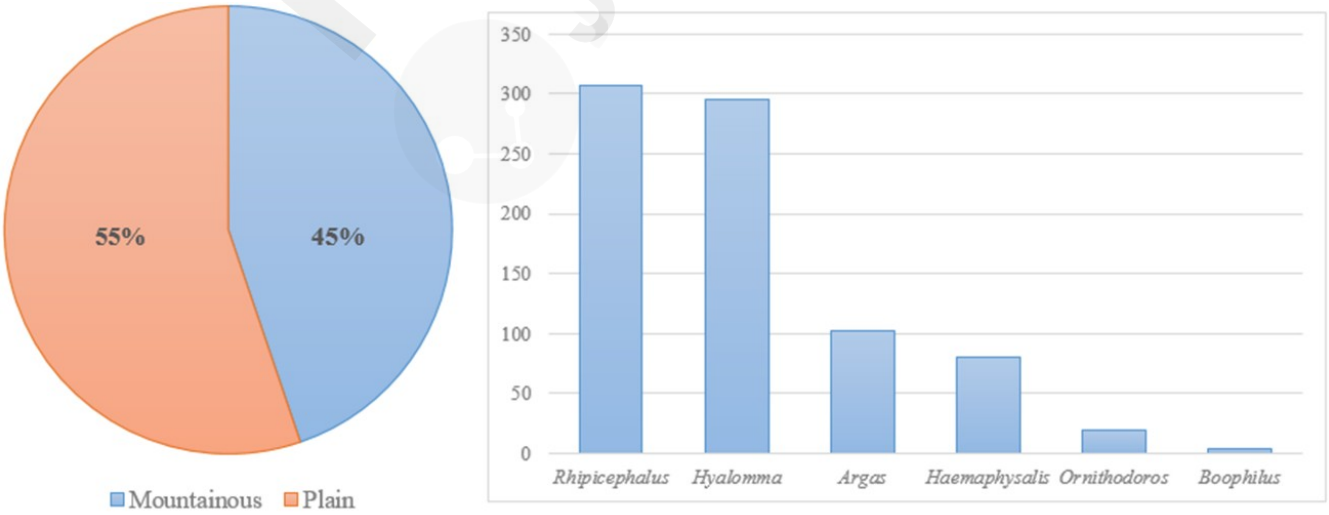

Figure 1. The ratio of caught ticks according to climatic topography, Tehran Province, 2019

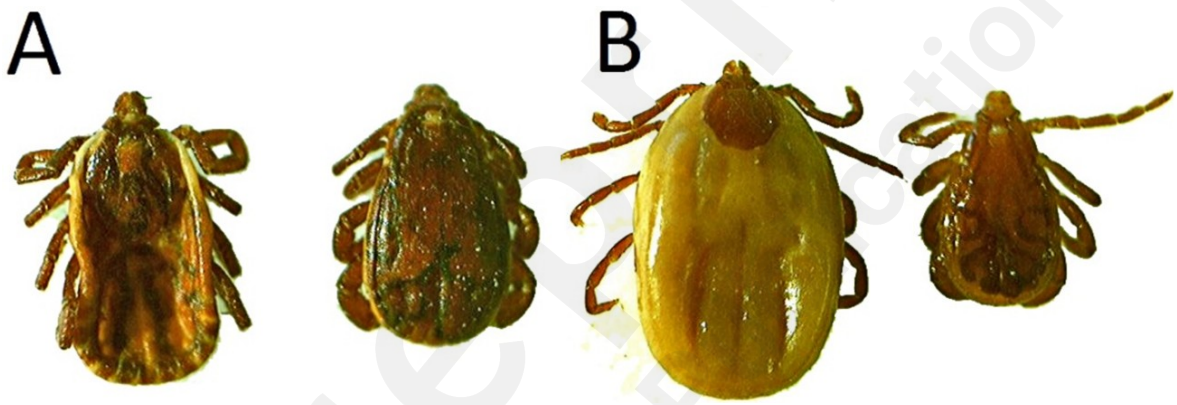

Figure 2. Rear view (A) male right and left female ***Rhipicephalus sanguineus*** and (B) male right and left female ***Rhipicephalus bursa*** (Original)

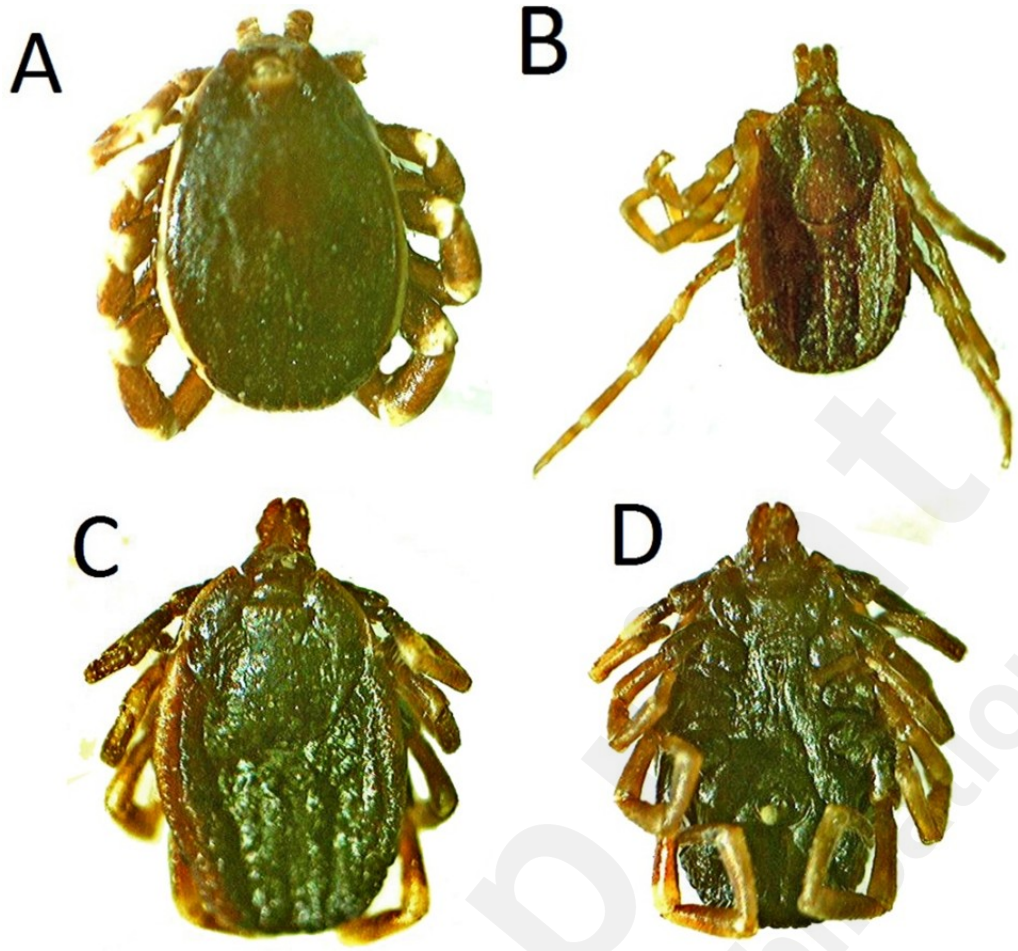

Figure 3. Rear view (A) of male and (B) female ***Hyalomma marginatum*** tick and dorsal view (C) of female and abdominal (D) female ***of Hyalomma detritus*** tick (Original)

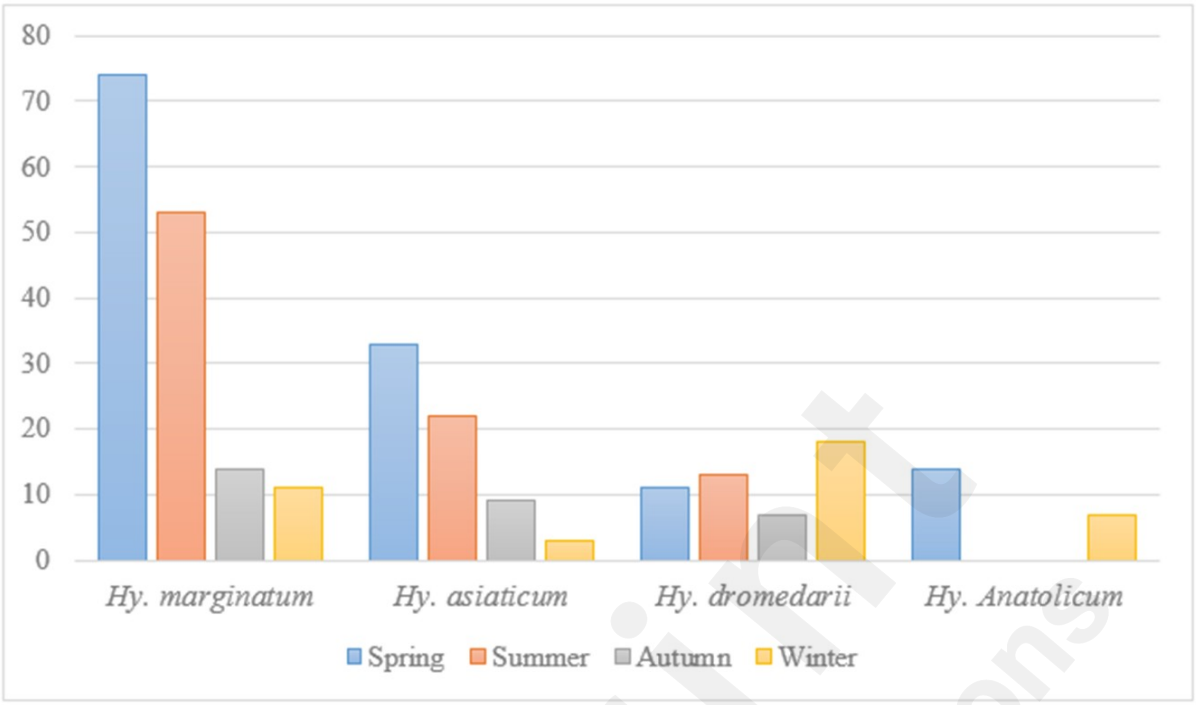

Figure 4. Frequency distribution of *Hyalomma* tick's species according to seasonal activity, Tehran Province, 2019

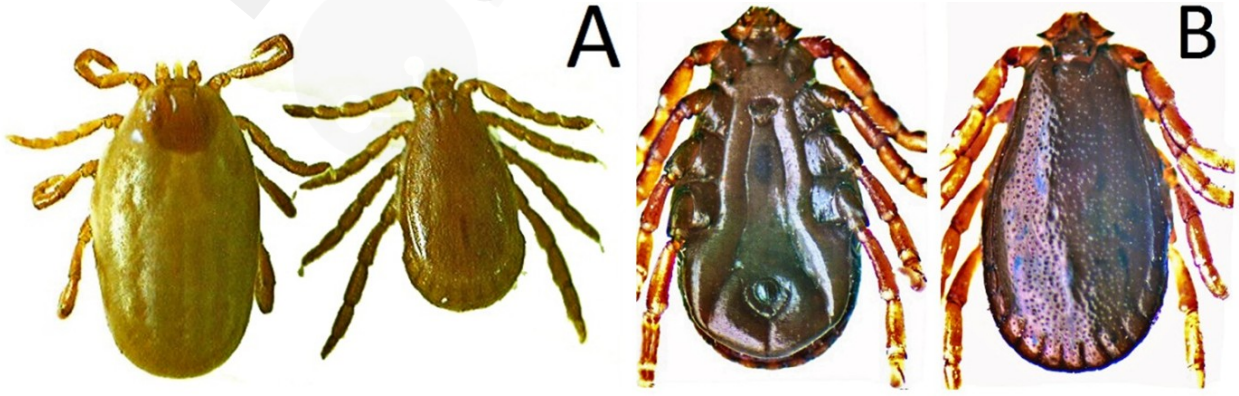

Figure 5. Rear view (A) of right male and left female ***Haemaphysalis sulcata*** and (B) Abdominal view of ***Haemaphysalis erinasei*** (Original)

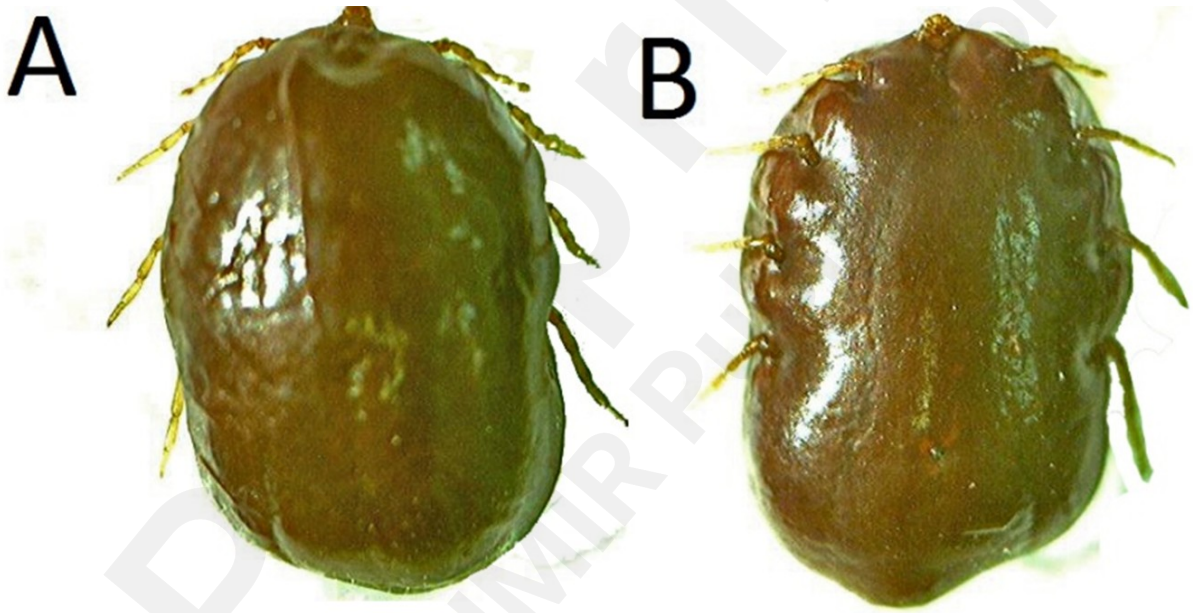

Figure 6. Back view (A) and abdominal view (B) of female ***Rhipicephalus (Boophilus) annulatus*** (engorge) tick (Original)

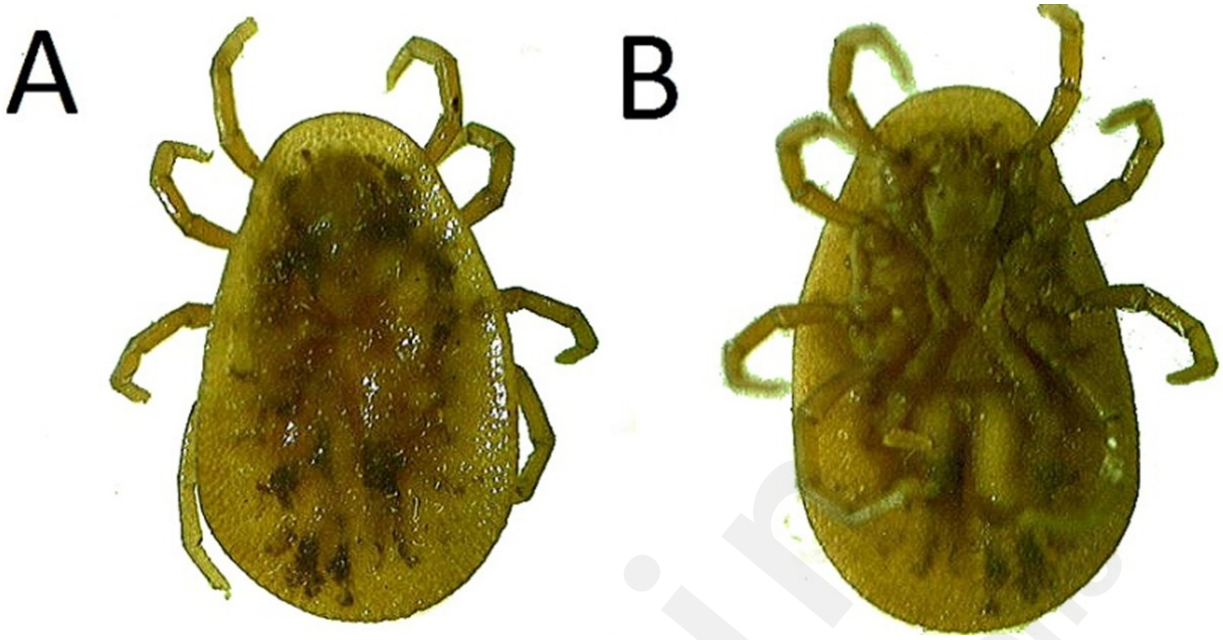

Figure 7. Back view (A) and abdominal view (B) of ***Argas persicus*** tick (Original)

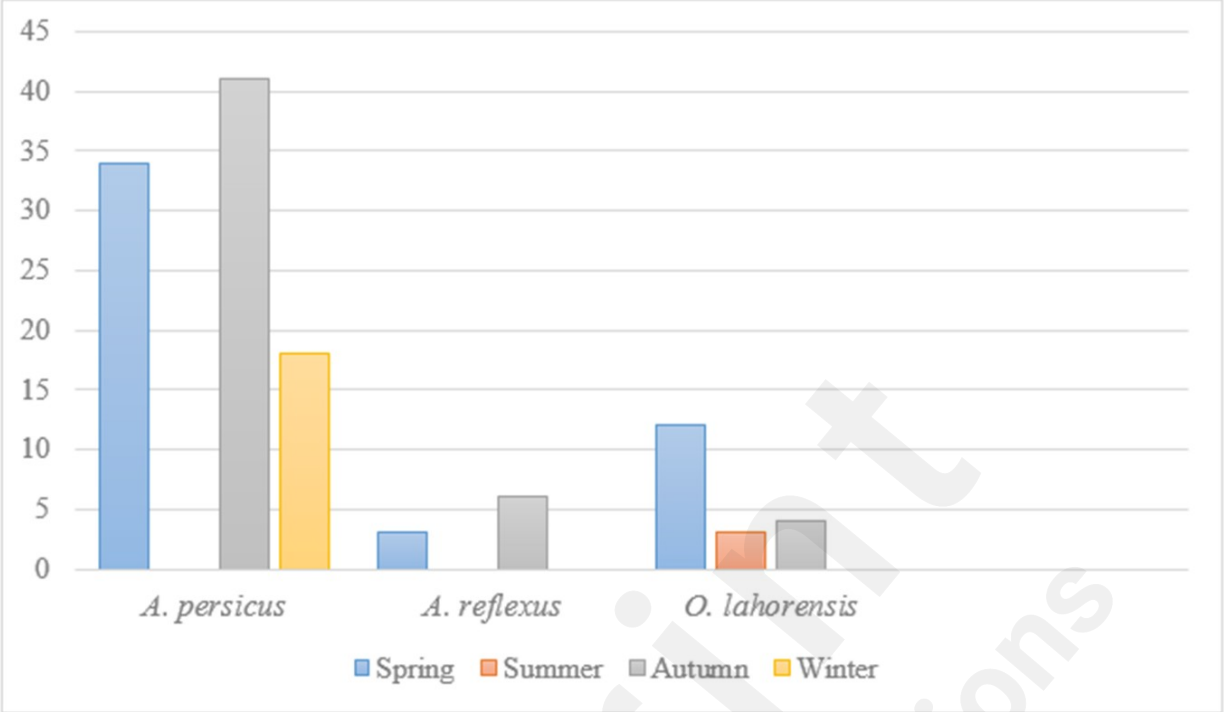

Figure 8. Frequency distribution of soft tick's species according to seasonal activity, Tehran Province, 2019

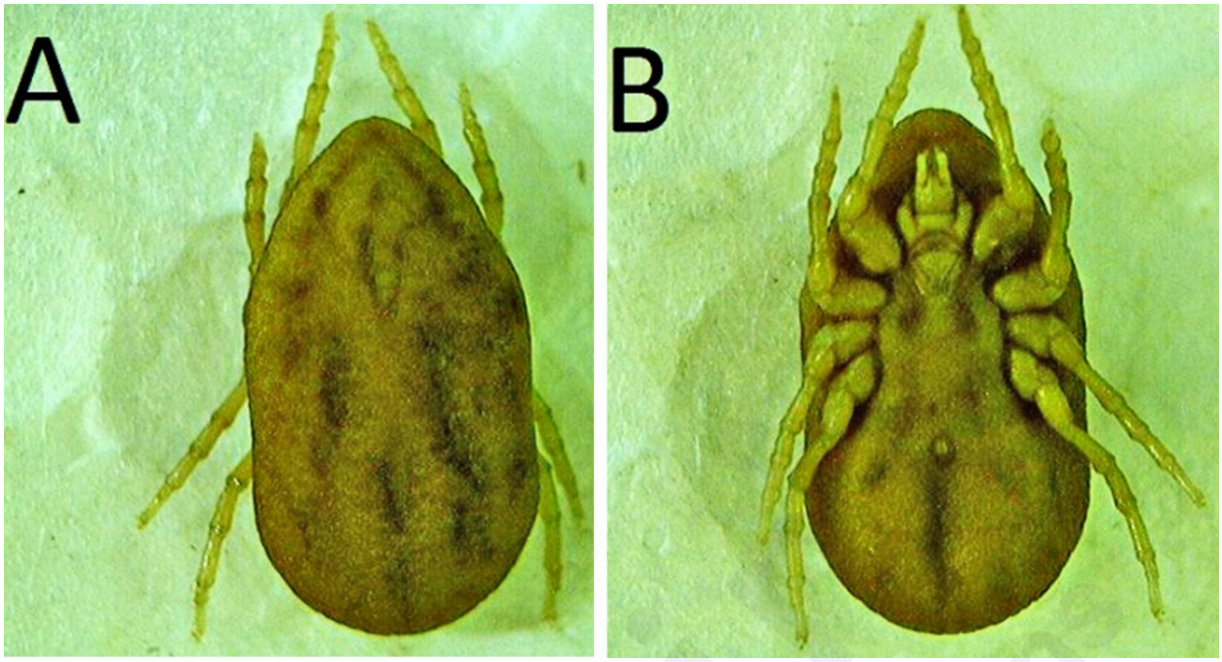

Figure 9. Back view (A) and abdominal view (B) ***Ornithodoros lahorensis*** tick (Original)

Supplementary Files