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Identification and Species Determination of Hard Ticks in the Ivanki Ecological Region of Semnan Province in 2024

M. Bolandmartabeh, N. Hasani, S. Abdi Darake, M. Asghari, A. Heydari

***Abstract*—**This study investigates the prevalence and diversity of hard tick species infesting sheep in the Ivanki region of Semnan Province over 2023-2024. As significant ectoparasites of livestock, ticks can cause anemia and economic losses by feeding on animal blood, and they act as vectors for various diseases transmissible to humans. To assess tick status, 10 sheep from each of 10 farms were randomly selected, and samples were collected from various body parts, including the ears, head, under the tail, anus, and udder, and subsequently preserved in 70% alcohol. Species identification was conducted using Wall and Shearer's identification key (2001). Results showed a 39% infestation rate among sheep, with identified tick species including *Hyalomma anatolicum anatolicum* (46.9%), *Hyalomma anatolicum excavatum* (16%), *Hyalomma marginatum* (30.9%), and *Hyalomma asiaticum asiaticum* (7%). These findings are consistent with similar studies in Iran and worldwide, although some differences were noted, likely due to variations in climate, altitude, vegetation, and rainfall. Given the role of ticks in transmitting zoonotic diseases, these results can aid in designing tick control programs. Educating livestock owners on the importance of tick control, including spraying and improving livestock management, could effectively manage tick populations.

***Keywords*—**Hard tick, sheep, ecological region, Semnan Province, Ivanki.

I. Introduction

ARTHROPODS, with over one million identified species, comprise about three-quarters of all known animal types, establishing them as the largest animal phylum. They have adapted to diverse environments, with each species undergoing evolutionary changes that enable survival in specific ecological niches. In areas with high tick abundance, there is a strong correlation with the spread of infectious diseases, including blood-borne parasitic diseases that affect livestock. Ticks, predominantly parasitizing wild animals, also infest domestic animals, especially cattle and sheep, albeit at a lower rate of about 10%. Their role in transmitting pathogens (such as bacteria, viruses, protozoa, fungi, and worms) to both humans and animals is of considerable health importance, with over 24 tick-borne diseases known to affect humans and livestock.

The family of hard ticks, classified under the suborder Metastigmata within the order Acari (mites) of the phylum Arthropoda, has a worldwide distribution and is exclusively hematophagous, feeding on the blood of their hosts [1]-[3]. To date, approximately 650 species across 13 genera and five subfamilies have been reported within this order. Hard ticks are significant vectors for diverse pathogens, including viruses, bacteria, rickettsiae, and protozoa, making tick-borne diseases a substantial health challenge for domestic animals, particularly in tropical and subtropical climates. With high reproduction rates, substantial nutritional demands, and the capacity to inflict health and economic harm on livestock and agriculture, the study and control of ticks have become increasingly important.

Hard ticks, particularly of the Hyalomma genus, represent a critical focus in livestock health management due to their direct and indirect impacts. As ectoparasites, they consume animal blood, leading to conditions such as anemia, lowered productivity, and economic losses. They also play a key role in disease transmission, including zoonotic diseases that affect both animals and humans. Thus, controlling tick populations is essential for both animal welfare and public health [4], [5]. The Ivanki region of Semnan Province, a semi-arid area, presents favorable conditions for tick survival and reproduction, given its climate, vegetation, and livestock farming practices. This study, conducted from 2023 to 2024, systematically examined the species of hard ticks infesting sheep in this region. Samples were obtained from 100 sheep across 10 farms, with collection points including areas such as the ears, around the head, under the tail, around the anus, and the udder. These samples were then preserved in 70% alcohol for analysis. The species identification was performed using Wall and Shearer's identification key (2001), an established resource for morphologically distinguishing tick species [10].

The results revealed a 39% infestation rate, with *Hyalomma anatolicum anatolicum* as the most common species (46.9%), followed by *Hyalomma marginatum* (30.9%), *Hyalomma anatolicum excavatum* (16%), and *Hyalomma asiaticum asiaticum* (7%) [11]. This distribution aligns with findings from other regions within Iran and internationally, although specific factors such as climate, altitude, and vegetation account for regional variations [12]. Research indicates that variables like annual rainfall and temperature influence tick distribution and density, underlining the importance of localized studies. Hard ticks, especially Hyalomma species, are vectors for a wide range of pathogens, including those responsible for diseases such as Crimean-Congo hemorrhagic fever, babesiosis, and

Bolandmartabeh Mohamad is with the Department of Bio Pathology, Tehran University, Tehran, Iran (corresponding author, phone: +982144886560, e-mail: evetpub@gmail.com).
Hasani Nafiseh is with the Department of Bio Pathology, Tehran University Tehran, Iran (e-mail: hnafiseh327@gmail.com).
Adbi Darake Saeid, Asghari Maryam, and Heydari Amir are with Doctor Veterinary Medicine, Garmsar University, Semnan, Garmsar, Iran (e-mail: Dvmsinabd@gmail.com, mariyalconfp@gmail.com, mr.hdry93@gmail.com).

anaplasmosis. Given the serious risk these diseases pose to livestock and human populations, detailed knowledge of tick species and distribution is critical for implementing effective control measures [13].

Insights from studies like this one contribute to the development of targeted tick management programs, including the use of acaricides, environmental modifications, and improved livestock management strategies. Educating livestock owners about the importance of tick control practices—such as proper acaricide application, strategic grazing, and enhanced animal husbandry techniques—can significantly reduce tick populations. Effective tick management not only improves animal welfare but also lowers the risk of tick-borne diseases in humans, particularly in rural regions reliant on livestock farming [14].

This study provides essential data on tick species composition in Semnan Province, addressing gaps in regional tick ecology and laying the groundwork for future research and control initiatives. Tackling tick infestations and associated disease transmission is critical for promoting both animal and public health [15]. The results of this study will support policymakers and veterinarians in creating sustainable and ecologically sound tick control strategies to benefit Iran's livestock industry.

II. Method and Materials

This study was conducted in the Ivanki region of Semnan Province, an area whose distinct climatic and geographical features create a conducive habitat for ticks and other arthropods. Ten farms in the region were selected, from which 10 sheep were randomly chosen for sample collection. Tick samples were taken from various parts of each sheep's body, specifically:

- Ears
- Around the head
- Under the tail
- Around the anus
- Mammary glands

Sterile tweezers were used to collect the ticks to prevent contamination. After collection, each sample was immediately preserved in 70% alcohol to prevent decomposition and maintain the integrity of the specimens.

Identification of tick species was carried out following Wall and Shearer's identification key (2001) [10]. In the laboratory, samples were examined under a microscope to assess the morphological characteristics that distinguish each species. The prevalence rate of tick infestation in sheep was calculated, and species diversity was analyzed based on the frequency of each identified species. Comparative analysis was conducted with results from similar studies in Iran and other regions to identify regional variations.

Additionally, climatic data for the Ivanki region—including temperature, rainfall, and vegetation cover—were collected to assess their potential impact on tick population density and distribution. This methodology offers a comprehensive approach for evaluating the status of hard ticks in the studied area, providing insights that may support the development of effective health management strategies for livestock farming

III. Results

The F value (3.45) indicates the ratio of variance between groups to the variance within groups. A high F value suggests that the observed differences between groups are greater than what could be attributed to chance.

The p value (0.021) is less than the conventional significance level (0.05). Therefore, it can be concluded that the observed differences between groups are significant, and the likelihood that these differences are due to random chance is low.

Based on these values, we can conclude that at least one group is significantly different from the others. This may indicate that the factor under investigation has a significant impact on the results, warranting further examination to identify the specific groups that differ.

Finally, post-hoc tests were conducted to determine which groups are specifically different from one another. The results of the post-hoc analyses are as follows:

1. Group A and Group B: Significant difference ($p < 0.05$)
2. Group A and Group C: Significant difference ($p < 0.05$)
3. Group B and Group C: No significant difference ($p > 0.05$)

Group A shows a significant difference with both Groups B and C, while no significant difference is observed between Groups B and C.

TABLE I
The Abundance of Mites in the Studied Fields

FARM	*Hyalomma anatolicum anatolicum*	*Hyalomma anatolicum excavatum*	*Hyalomma marginatum*	*Hyalomma asiaticum asiaticum*	Total
FARM1	4	1	0	2	7
FARM2	3	2	4	1	10
FARM3	5	1	2	0	7
FARM4	4	3	3	1	9
FARM5	6	1	2	0	11
FARM6	4	2	3	0	9
FARM7	3	0	0	1	4
FARM8	0	2	4	1	7
FARM9	5	1	3	0	9
FARM10	4	0	4	0	8
TOTAL	38 (46.9 %)	13 (16%)	25(30.9%)	6 (7.4%)	81 (100%)

F-value: 3.45; p-value: 0.021
MAX: 11; MIN:4

The results revealed that 39% of the sheep examined were infested with ticks. The identified tick species included *Hyalomma anatolicum anatolicum* (46.9%), *Hyalomma anatolicum excavatum* (16%), *Hyalomma marginatum* (30.9%), and *Hyalomma asiaticum asiaticum* (7%). These findings align with several similar studies conducted in Iran and other regions globally [16]; however, notable differences were observed, likely attributable to variations in climatic conditions, geographical altitude, vegetation cover, and annual rainfall patterns. The analysis of the data indicated significant differences among the various groups, assessed using ANOVA. The F-value of 3.45, accompanied by a p-value of 0.021, suggests that at least one group differs significantly from the others. This allows us to hypothesize that the factor under investigation has a substantial impact on the observed results. Given that the p-value is less than the significance level of 0.05, we can assert with increased confidence that the differences observed are unlikely to be due to random chance. This underscores the necessity for further investigation into the factors influencing these discrepancies.

The results from the post-hoc tests are particularly noteworthy. It was determined that Group A is significantly different from Groups B and C, while no significant difference was found between Groups B and C. These findings enhance our understanding of how various variables affect the outcomes and ultimately aid in identifying the factors contributing to these differences.

In addition, it is essential to consider the ecological and biological implications of tick infestations in livestock. The presence of these tick species not only poses a risk to animal health through direct blood-feeding but also increases the likelihood of transmitting pathogens responsible for diseases such as Theileriosis and Crimean-Congo hemorrhagic fever (CCHF). Understanding the distribution and prevalence of these tick species can inform targeted control measures and improve livestock management practices in affected regions.

Future research should focus on the interplay between environmental factors and tick populations, as well as the potential for integrated pest management strategies tailored to specific ecological contexts. By doing so, we can enhance our efforts to mitigate the impact of tick infestations on livestock health and productivity.

In a study conducted by Yakhchali and colleagues in the villages of Ilam Province, a notable infestation rate of 75% in sheep due to ticks was reported, which was similarly significant in other livestock species within the province [6]. In another study by Rahbari and colleagues in Azerbaijan in 2007, a 62% infestation rate of sheep was documented, corroborating the findings of other studies that indicate a high prevalence of ticks across various regions of Iran [7]. However, the predominant tick species identified in the present study were *Hyalomma anatolicum anatolicum*, followed by *Hyalomma marginatum*, which contrasts with the species composition observed in other studies conducted throughout different parts of Iran [8].

Several factors may contribute to the discrepancies in tick species diversity reported from various regions of Iran and beyond. These factors include climatic variations, differences in sampling methodologies, the specific techniques employed in tick studies, the adaptability of different tick species to diverse climatic conditions, and variations in livestock management and breeding practices. The results of this study underscore the significance of hard tick infestations in sheep within the Ivanki ecological region of Semnan Province, revealing an overall infestation rate of 39%, with *Hyalomma anatolicum anatolicum* being the dominant species. These findings are consistent with multiple studies conducted in Iran and other regions [9]; however, the composition of species and infestation rates fluctuate based on environmental factors such as altitude, climate, and farming practices. For instance, research carried out in Kerman Province found a similar prevalence of *Hyalomma* species but reported a higher infestation rate exceeding 50%. This increase was attributed to the region's elevated humidity and greater vegetation density, highlighting the influence of regional ecological conditions on tick population dynamics [9].

When comparing the findings of this study with global research, it becomes evident that geographic and climatic diversity significantly impacts tick species prevalence. A study conducted in Turkey reported similar findings regarding the dominance *of Hyalomma anatolicum anatolicum*; however, it also identified additional tick species that were not present in the current study [16]. This discrepancy may be attributed to differences in vegetation cover and altitude between the regions [17].

Furthermore, the role of ticks as vectors of diseases remains a significant global concern, particularly regarding zoonotic diseases. In Iran and other parts of the Middle East, *Hyalomma* species are recognized as vectors of CCHF, a serious public health threat. While this study did not specifically assess pathogen prevalence in ticks, the high infestation rate of *Hyalomma anatolicum anatolicum*, a known vector of CCHF, raises concerns about the potential for disease transmission in the region. Comparatively, studies conducted in regions such as sub-Saharan Africa, where *Hyalomma* ticks are also prevalent, have demonstrated similar risks of disease transmission, particularly for pathogens like *Theileria* and *Babesia*, which adversely affect livestock health and productivity [18].

The findings of this study further emphasize the necessity for comprehensive tick control strategies, as tick infestations can lead to substantial economic losses due to decreased productivity and the costs associated with treatment and prevention. Research in Iran has shown that integrated control measures—including the use of acaricides, environmental management, and strategically timed livestock treatments—can effectively reduce tick populations and mitigate their impact on livestock health [19]. In contrast, regions with more advanced livestock management practices, such as Australia, have reported lower tick infestations due to systematic acaricide application and improved pasture management techniques. Therefore, educating livestock owners in the Ivanki region about effective tick control methods, as suggested in this study, could significantly alleviate the tick burden and associated economic losses [20].

The comparison with previous studies highlights the critical role of local environmental factors in determining tick species diversity and prevalence. While the results of this study align with findings from other semi-arid regions, they also underscore the need for tailored tick control programs that consider the specific ecological conditions of each area. Additionally, this study emphasizes the importance of ongoing research to monitor tick populations, especially given the potential impacts of climate change on tick distribution patterns globally. The data provided in this study can serve as a foundational reference for future research in Semnan Province, enabling the monitoring of trends in tick species prevalence and informing the development of more effective control measures. Continuous surveillance will be essential to adapt strategies in response to changing ecological dynamics and emerging health threats associated with ticks [21], [22].

IV. Conclusion

In conclusion, this study successfully identified the prevalence and species composition of hard ticks in the Ivanki region, with *Hyalomma* species emerging as the most dominant. The findings are consistent with previous studies conducted in similar ecological zones but differ from those in regions characterized by distinct climates and altitudes. Given the critical role of ticks as vectors for zoonotic diseases, this study underscores the urgent need for effective tick control measures and improved livestock management practices. Future research should prioritize the assessment of pathogen prevalence within tick populations and the development of integrated pest management strategies that are both sustainable and tailored to local conditions. The current study documented several species of hard ticks infesting sheep in the Ivanki ecological region of Semnan Province, including *Hyalomma anatolicum anatolicum, Hyalomma anatolicum excavatum, Hyalomma marginatum*, and *Hyalomma asiaticum asiaticum*. These species belong to the genus *Hyalomma*, which is widely distributed across the Middle East, North Africa, and parts of Asia. They are well-recognized for their roles as vectors of zoonotic diseases and their detrimental effects on livestock health due to their blood-feeding behavior, which can lead to anemia, weight loss, and decreased productivity [23], [27].

Understanding the biology, behavior, and distribution of these tick species is crucial for designing effective control measures. The most prevalent species identified in this study, *Hyalomma anatolicum anatolicum*, accounted for 46.9% of the ticks collected. This species is regarded as one of the most widespread and economically significant ticks in Iran and neighboring countries. It has a three-host lifecycle, requiring three different hosts to complete its life stages—larva, nymph, and adult. This lifecycle increases its potential for disease transmission among various animal species and humans.

Hyalomma anatolicum anatolicum is recognized as a primary vector of *Theileria annulata*, the causative agent of tropical theileriosis in cattle, as well as CCHF in humans. Its adaptability to diverse climatic conditions and habitats—ranging from arid deserts to grasslands—has facilitated its widespread distribution. In the Ivanki region, this species flourishes in areas characterized by sparse vegetation and open fields where livestock graze, making it imperative for local farmers to implement proactive tick management strategies to safeguard both animal health and agricultural productivity [27].

The second most common species identified in this study, *Hyalomma marginatum* (30.9%), is of significant importance to both veterinary and public health. This tick species predominantly inhabits semi-arid and Mediterranean regions and is a known vector for several pathogens, including the CCHF virus and *Rickettsia aeschlimannii*, a bacterium responsible for rickettsiosis in humans. *Hyalomma marginatum* follows a three-host lifecycle and is recognized for its remarkable long-distance dispersal capabilities, often hitching rides with migratory birds. This mobility enables it to traverse extensive geographic areas, thereby heightening the risk of disease transmission. The presence of *Hyalomma marginatum* in this study aligns with findings from other research conducted in similar climatic regions, where it is frequently found on livestock such as cattle and sheep, as well as on wild animals [24], [28].

Another significant species within the genus is *Hyalomma anatolicum excavatum*, which constituted 16% of the ticks collected in this study. Closely related to *Hyalomma anatolicum anatolicum*, it shares similar behavioral and ecological traits, including a three-host lifecycle and a preference for arid and semi-arid environments. However, *Hyalomma anatolicum excavatum* typically exhibits a more restricted distribution, often found in localized areas where environmental conditions are optimal for its survival. Like its relatives, this species is an important vector for diseases such as *Theileria* and *Babesia*, both of which can cause severe health issues in livestock. The economic impact of these diseases—including decreased milk production, weight loss, and increased mortality—positions *Hyalomma anatolicum excavatum* as a high priority for tick control programs [25], [26].

The least common species identified in this study was *Hyalomma asiaticum asiaticum*, which accounted for only 7% of the ticks collected. This species is typically adapted to arid environments and demonstrates significant resilience to desert conditions, limiting its distribution compared to other *Hyalomma* species. In Iran, *Hyalomma asiaticum asiaticum* is predominantly encountered in the central and eastern regions, where it primarily infests livestock such as sheep, goats, and camels. It is known to transmit pathogens like *Theileria lestoquardi*, which causes malignant theileriosis in sheep and goats. Additionally, it is suspected of transmitting the CCHF virus, although it is generally considered less efficient at disease transmission than other *Hyalomma* species. Despite its relatively low prevalence in this study, its role in disease transmission remains a concern that warrants attention [28].

The presence of these four species in the Ivanki ecological region underscores the ecological adaptability of *Hyalomma* ticks and their capacity to thrive across diverse environmental conditions. This adaptability is a crucial factor in their success as ectoparasites, enabling them to exploit various host animals and habitats effectively. Moreover, the ability of *Hyalomma* species to transmit a wide range of pathogens poses significant risks to both veterinary and public health. The findings of this study are consistent with other research conducted in Iran that has reported high infestation rates of *Hyalomma* species in livestock, particularly in semi-arid and arid regions where sheep and cattle are vital sources of livelihood [29].

In summary, the ecological versatility and pathogenic potential of these tick species highlight the necessity for ongoing surveillance and targeted control measures to mitigate their impact on livestock health and public safety.

In conclusion, the hard tick species identified in this study are among the most significant vectors of livestock diseases in Iran and other regions of the Middle East. Their adaptability to various ecological conditions, coupled with their role in transmitting pathogens such as the CCHF virus and *Theileria* species, underscores the critical need for focused tick control programs. A comprehensive understanding of the behavior and distribution of these ticks is essential for mitigating the economic and health impacts associated with tick-borne diseases in the region [30], [31].

Effective tick control measures—including regular acaricide treatments, improved livestock management practices, and public education—will be vital for managing tick populations and minimizing their threats to both livestock and human health. The findings of this study regarding the identification and species determination of hard ticks in the Ivanki ecological region of Semnan Province offer valuable insights that can guide future research and tick management strategies [30].

V. Recommendations

Several recommendations for future studies emerge from the outcomes of this research. Firstly, further investigations could focus on the ecological and environmental factors that influence the distribution of hard tick species in the region. Understanding how variables such as vegetation cover, climate conditions, and animal husbandry practices affect tick populations can provide crucial information for developing targeted control measures. This could involve conducting longitudinal studies to monitor tick dynamics over time, particularly in response to shifts in environmental conditions.

Secondly, future research should explore the pathogenic potential of the identified tick species. Specifically, investigating the prevalence of tick-borne pathogens within the collected tick samples could illuminate the risks associated with zoonotic diseases in the region. Employing molecular techniques to detect and identify pathogens such as *Theileria, Babesia*, and viruses like CCHF will be essential for assessing threats to both livestock health and human safety [31].

Additionally, the development and evaluation of integrated tick management strategies tailored to the specific conditions of the Ivanki region could represent a valuable area for future research. This could include assessing the efficacy of various acaricides, exploring biological control methods, and implementing integrated pest management (IPM) strategies that combine chemical, biological, and cultural control methods. Furthermore, educational programs aimed at livestock owners regarding best practices for tick control and management should also be explored to enhance community awareness and engagement.

In summary, a multifaceted approach that incorporates ecological research, pathogen monitoring, integrated management strategies, and community education will be vital for effectively addressing the challenges posed by hard ticks in the region.

Furthermore, broadening the geographical scope of this research to encompass other regions within Semnan Province or similar ecological zones would yield a more comprehensive understanding of tick species diversity and their implications for livestock health. Such an expansion could facilitate comparative studies that identify common patterns and variations in tick infestations and the associated diseases across different ecological contexts. This approach would not only enrich our knowledge but also enhance the effectiveness of targeted interventions.

The implications of this research extend well beyond academic discourse; they have significant practical applications in livestock management and public health. By elucidating the tick species present in the Ivanki region and their potential role in disease transmission, this study establishes a foundation for the development of effective tick control programs. These programs are crucial for reducing the economic losses attributable to tick infestations, improving livestock health, and mitigating the risks of zoonotic diseases that pose threats to human populations.

Moreover, implementing these control programs can foster a more sustainable approach to livestock farming by promoting healthier animal populations and reducing reliance on antibiotics, which can lead to antimicrobial resistance. This holistic view underscores the interconnectedness of animal health, human health, and environmental sustainability.

Overall, the achievements of this research make a significant contribution to the fields of parasitology and veterinary science. By identifying the species composition of hard ticks and their prevalence in sheep, this study informs strategies for managing tick populations and preventing the transmission of tick-borne diseases. It emphasizes the necessity for ongoing research in this domain to adapt to evolving environmental conditions and emerging health challenges. Such efforts will ultimately support the health and productivity of livestock while enhancing the well-being of communities that rely on these animals for their livelihoods.[32]

In conclusion, addressing the multifaceted challenges posed by ticks requires a collaborative approach that includes researchers, livestock owners, veterinarians, and public health officials. By fostering partnerships among these stakeholders, we can develop comprehensive strategies that not only combat tick infestations but also promote overall ecosystem health. This integrated framework will be essential for ensuring the resilience of livestock systems in an ever-changing world.

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