

ARTICLE / INVESTIGACIÓN

Molecular identification and Phylogenetic-Tree Analysis of Hard Ticks from wild and domestic cat *Felidae* in Iraq

Afkar Muslim Hadi, Hind Dyaia Hadi*, Suhad Yasin Jassim

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Iraq Natural History Research Center and Museum, University of Baghdad, Iraq.
Corresponding author: hinddhiaa86@gmail.com

Abstract: A total of 13 samples of domestic cat *Felis catus* (Linnaeus, 1758) and 9 samples of wild cat *Felis chaus furax* (de Winton, 1898) of the Felidae Family were trapped and examined to detect the hard ticks. The areas of the collection were: Baghdad, Al-Rashidiya, Tharthar, Nahrawan, AL-Mahmoudiya (middle of Iraq) and AL-Haretha (south of Iraq), Mosul (north of Iraq). The results of the current study revealed that four species belong to two genera of hard ticks: *Haemaphysalis* sp. (Koch, 1844), *Rhipicephalus turanicus* (Morel, 1969), *Rhipicephalus sanguineus* (Neumann, 1904) and *Rhipicephalus appendiculatus* (Santos, 1955). The rates and the density of infestation were discussed. The current study aimed to clarify the infestation difference between domestic and wild cats with hard ticks (3, 14.88) because domestic cats enjoy human attention, as they live close to him. The current study identified the *Rhipicephalus appendiculatus* for the first time in Iraq from domestic cat *Felis catus*.

Key words: Felidae, *Haemaphysalis*, Ixodidae, *Rhipicephalus*, wild cat.

Introduction

Hard ticks were belonging to the Family Ixodidae consisting of 700 species. They have scutum or "hard shield" in the dorsal side of the body; therefore, they are called hard ticks¹ Tick usually carry many pathogenic microorganisms and parasites that cause diseases for both humans and animals² These may be bacteria, helminths, protozoa and viruses^{3,4} In Iraq, (5) revealed to the endemic area of Theileriosis and Babesiosis which transmitted by ticks. The current study aims to investigate a phenotypic description of the species of ticks that infest the domestic and wild cat (Family: Felidae). Second: look at tick biodiversity and complete an ecological map for the prevalence of tick species in domestic and wild animals.

Materials and methods

Collection of samples

A total of 13 samples of domestic cat *Felis catus* (Linnaeus, 1758) and 9 samples of wild cat *Felis chaus furax* (de Winton, 1898) of the Felidae Family were trapped and examined to detect the hard ticks. The areas of the collection were: Baghdad, Al-Rashidiya, Tharthar, Nahrawan, AL-Mahmoudiya (middle of Iraq) and AL-Haretha (south of Iraq), Mosul (north of Iraq). The infestation of hard ticks was in the animals' dorsal, femoral and udder. All the collected ticks samples were kept in sterile tubes containing 70% alcohol, and the place of collection and the females and males were recorded on it. Ticks sampled were transported to the Iraq Natural History Research Center and Museum (INHM) for examining, diagnosing and photographed with a digital camera.

Results and discussion

33 (17 female & 16 male) hard ticks samples were isolated from 13 domestic cats, and 134 (44 female & 90 male) hard ticks samples were isolated from 9 wild cats. The infestation rates were 84.61% and 100% in domestic and feral cats, respectively. The infestation density was 3, 14.88 in domestic and wild cats, respectively. (Table 1).

The results of the current study revealed that four species belong to two genera of hard ticks: *Haemaphysalis* sp. (Koch, 1844), *Rhipicephalus turanicus* (Morel, 1969), *Rhipicephalus sanguineus* (Neumann, 1904) and *Rhipicephalus appendiculatus* (Santos, 1955), as in table 2 and figures (1-4).

The biodiversity of ticks in domestic and wild animals is an important topic to study that highlights to the reservoir hosts which play a role in distribution of ticks and disease. The current study revealed a clear difference in the infestation density between domestic and wild cats with hard ticks (3, 14.88); domestic cats enjoy human attention, as they live close to him. *Rhipicephalus turanicus* appeared in both domestic and wild cats; this result agrees with (6,7). They revealed domestic cats infested with *Rhipicephalus turanicus*. Previously, (8) Recorded *Rhipicephalus turanicus* in wild cats. *Rhipicephalus sanguineus* was recorded in the Canidae previously in Iraq by (8,6), while (9) recorded it in dogs and humans in Daiwania city; so this recording in wild cat *Felis chaus furax* in the current study consider a new host for *R. sanguineus*. The present study identified the *Rhipicephalus appendiculatus* for the first time in Iraq from domestic cat *Felis catus*; this result agrees with 10 who revealed to *R. appendiculatus* in feline (Sable). The current results recorded the *Haemaphysalis* sp. in wild cat *Felis chaus furax*. While (8,6) isolated *Haemaphysalis Adler* from the Wild jungle cat.

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Host	No. of exam samples	No. of infest samples	%	No. of ticks	Infestation density
Domestic cat	13	11	84.61	33	3
Wild cat	9	9	100	134	14.88

Table 1. Total rates and the density of infestation hard ticks for Felidae in Iraq.

Host	<i>R. turanicus</i>	<i>R. sanguineus</i>	<i>R. appendiculatus</i>	<i>Haemaphysalis</i>
Domestic cat	11 ♀, 13 ♂	5 ♀, 4 ♂
Wild cat	31 ♀, 29 ♂	8 ♀, 15 ♂	7 ♀, 46 ♂

Table 2. Distribution of complex ticks species in domestic and wild cats in Iraq.

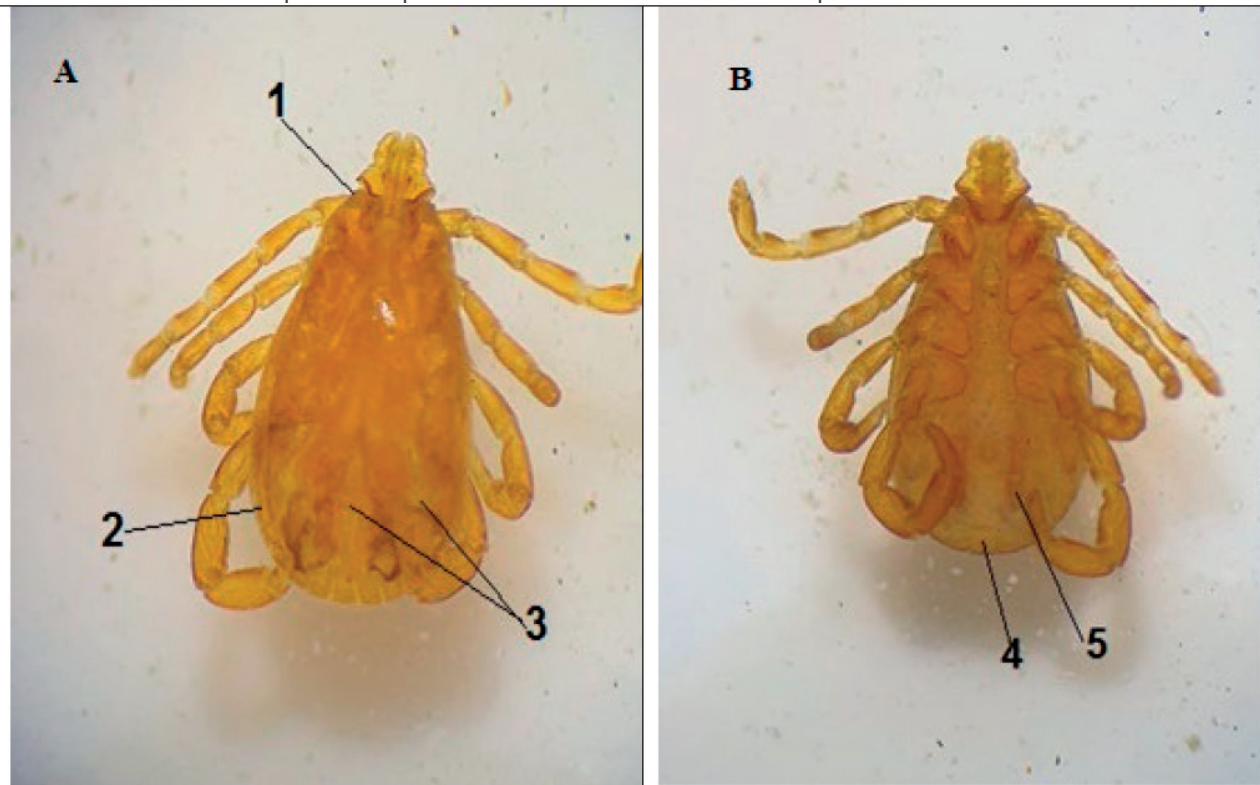


Figure 1. Dorsal A and ventral side B of *Rhipicephalus turanicus* in Felidae in Iraq. 1. Coxae 1 anterior spurs are not visible dorsally. 2. Lateral groove type is a distinct groove. 3. Posterior grooves are distinct grooves. 4. Caudal appendage is broad in fed males. 5. Adanal plate shape is narrow and trapezoid.

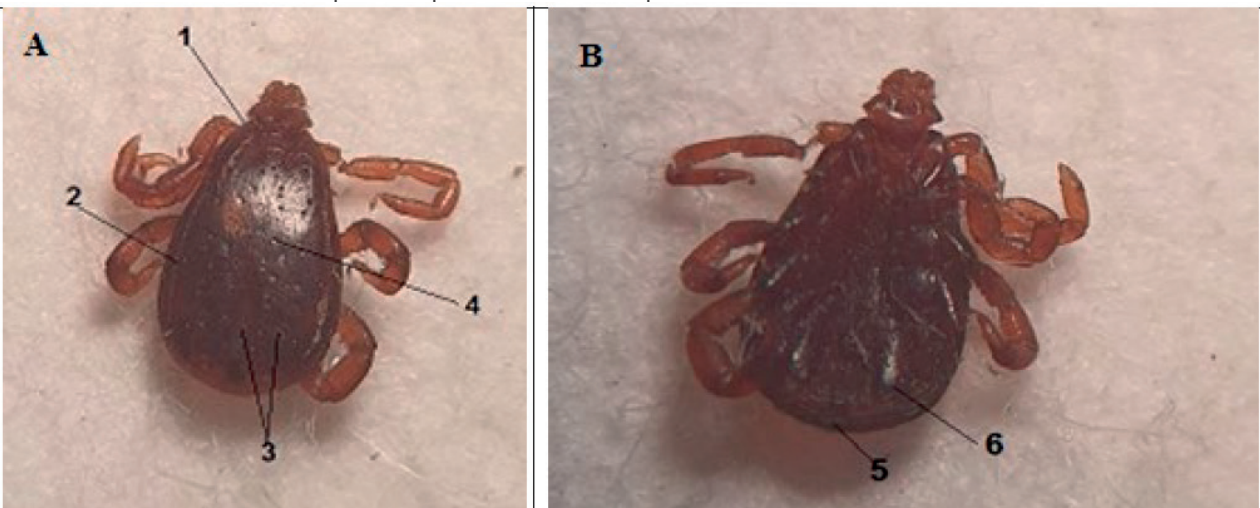


Figure 2. Dorsal A and ventral side B of *Rhipicephalus sanguineus* in wild cats in Iraq. 1. Coxae 1 anterior spurs are not visible dorsally. 2. Lateral groove type is a distinct groove. 3. Posterior grooves are distinct grooves (deep and wide with wrinkled texture). 4. Conscutum color is dark. 5. Caudal appendage is broad in fed males. 6. Adanal plates shape are abroad and curved appearance.



Figure 3. Dorsal A and ventral side B of *Rhipicephalus appendiculatus* in domestic cats in Iraq. 1. Coxae 1 anterior spurs are visible dorsally. 2. Lateral groove type is a distinct groove. 3. Posterior grooves are distinct grooves (shallow with wrinkled texture). 4. Caudal appendage is narrow in fed males. 5. Adanal plates shape is narrow and trapezoid.

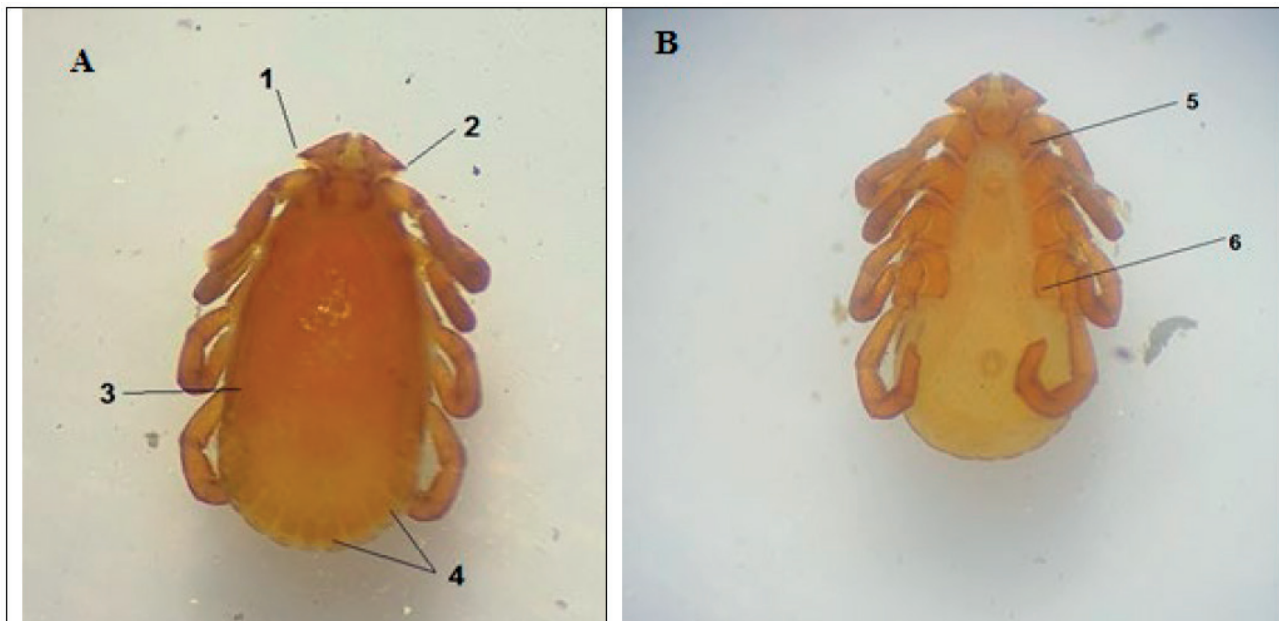


Figure 4. Dorsal A and ventral side B of *Haemaphysalis* sp. in wild cats in Iraq. 1. Palp articles 2 lateral extension is large (the palps form a distinctly conical shape). 2. Palp articles 2 dorsal spur is present. 3. Fестоons enclosed by each lateral groove. 4. Fестоон numbers = eleven.

Review for Molecular Identification and Phylogenetic-Tree Analysis of Hard Ticks

The sequencing of the genus *Rhipicephalus* was reported as follows: *Rhipicephalus turanicus*, Seq1 (MN999872), Seq2 (MN999873), Seq3 (MN999874) and Seq4 (MN999875) by (11) In Iraq. *R. appendiculatus* (MK551199) was reported by (12) In South Africa. *Rhipicephalus sanguineus* (MG386819) was reported by (13) in Portugal. The sequencing of the genus *Haemaphysalis* sp. is not represented in Iraq, while, in China *Haemaphysalis parva* (FN296280), *Haemaphysalis punctata* (FN296264) by (14) And *Haemaphysalis flava* (JQ737122), *Haemaphysalis doenitzi* (JQ346685) by (15). Morethan, *Haemaphysalis longicornis* (MF490294) and (MF490308) by (16)

In South Africa, (17) revealed to the *Haemaphysalis leachi* (MN661151). *Haemaphysalis adleri* was not reported in NCBI till now.

Conclusions

The biodiversity of ticks in domestic and wild cats alike is an important topic to study that highlights the reservoir hosts who play a role in the distribution of ticks and, therefore, diseases. The current study revealed apparent differences in the infestation density between domestic and wild cats with hard ticks. *Rhipicephalus turanicus* appeared in both domestic and feral cats. The present study recorded *Rhipicephalus sanguineus* in wild cat *Felis chaus furax*; this

recording was considered a new host for *R. sanguineus*. The current study identified the *Rhipicephalus appendiculatus* for the first time in Iraq from domestic cat *Felis catus*. The present results recorded the *Haemaphysalis sp.* in wild cat *Felis chaus furax*.

Supplementary Materials

The following are available in this PDF, Table S1: Composition culture medium, Sheet 1 S2: Total cost, Sheet 2 S2: Stages of production, Sheet 3 S2: Direct and indirect labor, Sheet 4 S2: Culture medium, Sheet 5 S2: IMC, Sheet 6 S2: 6. Assumptions.

Author Contributions

Conceptualization, Ana María Henao Ramírez and Aura Inés Urrea Trujillo; methodology and software, Hernando David Palacio Hajduck and Ana María Henao Ramírez; validation and formal analysis, Ana María Henao Ramírez; investigation, resources, data curation, writing—original draft preparation, Ana María Henao Ramírez; writing—review and editing and supervision, Aura Inés Urrea Trujillo. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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