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RESEARCH ARTICLE

IXODID TICKS DIVERSITY IN THE MIDDLE AND SOUTH OF IRAQ

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ABSTRACT

A survey for ixodid ticks among 21 domestic and wild animals was conducted in the middle and south of Iraq encountered examining 2052 hosts revealed presence of 13 tick species. A total of 975 animals (47.51%) were found infested with one or more tick species. In regard to host infestation rates among domestic animals, camels attain the highest infestation rate of 65.77%, then dogs (56.25%), horses (50%), cows (47%). Sheep (46.9%), water buffaloes (42.15%), goats (25.94%), donkeys (20%) and domestic cats (4.87%). In regard to infestation rates in wild animals, red foxes, Asiatic jackals and common otter were with 100% rate, followed by wild hares (81.25)%, long-eared hedgehog (76.19%), wild boar and wild jungle cat (66.66%), black bird (50%), ratel, crested lark and grey hypocolius (33.33%), and black rat (20%). Some ticks showed high host specificity (*Hyalomma schulzei* and for a lesser extent *Hyalomma dromedarii*, *Rhipicephalus sanguineus* and *Haemaphysalis adleri*), while others were with a wide range of hosts (*Hyalomma anatolicum* and *Rhipicephalus turanicus*).

INTRODUCTION

Ticks represent a very successful animal group and show a wide spectrum of adaptations for both of host and environment [1]. They are rather old, and many specimens of ticks were found in Myanmar amber related to Cretaceous period about 100 Mya [2,3]. The extant ixodid ticks accounts over 700 species [4,5]. They are obligatory ectoparasites feeding on blood of terrestrial vertebrates. They have extreme economic, veterinary and medical importance as they cause direct effect on their animal hosts like blood and weight losses and act as vectors of different viral, bacterial and protozoal disease agents as well as playing an important role in zoonosis [6,7,8].

The ixodid ticks of Iraq are rather well documented beginning with the collection of Dr. P. A. Buxton during the years of World War I deposited in the British Museum [9]. Patton [10] commented on *Boophilus annulatus*, [11] reported on dog and human infestations with *Rhipicephalus s. sanguineus* in Baghdad, then he noticed that it infest the long eared hedgehog *Hemiechinus auritus* [12]. A list of 7 identified ixoidid to species level and another 4 to genus level was published by [13]. Then [14] in a report forwarded to the Iraqi Government, identified 8 ixodid ticks collected from cattle.

The work of [9] is considered one of the most comprehensive work ever done on Iraqi ticks giving keys, host-parasite relationships and geographical distribution depending on 4450 specimens related to 21 species including *Ixodes tatei* which was described by [15]. Then[16] published a list of 18 species of ticks, 4 of them were new records. [17] prepared a list of identified insects and arachnids included 8 ixodid tick species. A series of 7 papers studied the seasonal incidence and distribution of ticks infesting the domestic animals in Iraq [18-24]. These studies added 4 new records. [25] submitted arthropod list of medical and veterinary importance included 28 ixodid ticks. Then [26] studied the incidence, host-parasite relationships and geographical distribution of 12 ixodid tick species with special emphasis on wild animals. Two tick species were recorded from Iraqi hedgehogs [27]. [28] in his survey of ectoparasites on horse in Baghdad area reported 4 ixodids. [29] surveyed the ixodid ticks of both domestic and wild animals and recorded 33 species and subspecies of ixodid ticks in Iraq including six new records and provided identification key. [30] noticed that *Hyalomma anatolicum* was the most common ixodid tick species in Iraq. A paper on the parasitic fauna of the red fox *Vulpes vulpes* in Iraq, found 5 tick species belonging to genera *Haemaphysalis*, *Ixodes*, and *Rhipicephalus* [31] while [32] surveyed the ticks in Basra province and reported *Hyalomma asiaticum* from cows for the first time in southern parts of Iraq. [33] surveyed domestic cats in Baghdad area and found 2 ixodids belong to genera *Ixodes* and *Rhipicephalus*. Tuama [34] examined farm animals in Thi Qar province, south of Iraq and found 3 ixodids. [35] recovered 4 ixodid species from wild jungle cat *Felis chaus furax* belong to genera *Haemaphysalis*, *Hyalomma*, and *Rhipicephalus* in the middle of Iraq. [36] reported 4 ixodid species in the cows in Al-Diwaniya province.[37] found *Boophilus* spp. and *Hyalomma* spp. infest camel *Camelus dromedarius* in Al-Diwaniya province. [38,39,40] studied the ixodid fauna infest sheep in the middle of Iraq and recorded up to 8 species.

The aim of the present work is to study the species diversity of the ixodid ticks, host-parasite relationships and infestation rates among domestic and wild animals in the middle and south of Iraq.

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MATERIALS AND METHODS

A survey for ixodid ticks among domestic and wild animals was conducted at the middle and south of Iraq between the March 2012- Feb. 2013. The provinces included in this study are Baghdad, Wasit, Babil, Al-Diwaniya, Al-Muthana, Al-Najaf Al-Ashraf, Kerbala, Missan, Basra and Thi Qar. A total of 5639 ixodid ticks were recovered from 2052 examined animals. The number of species of examined hosts are 21, 9 of them are domestic animals including cow *Bos Taurus* (number of examined animals is 534) water buffalo *Bubalus bubalis* (223), sheep *Ovis aries* (597), goat *Capra hircus* (212), horse *Equus caballus* (10), donkey *Equus asinus* (5) ; camel *Camelus dromedarius* (336); domestic cat *Felis catus* (41) and dog *Canis familiaris* (16); while the wild animals include wild hare *Lepus capensis* (16), red fox *Vulpes vulpes* (4), Asiatic jackal *Canis aureus* (14), wild jungle cat *Felis chaus* (3), wild boar *Sus scrofa* (3), ratel *Mellivora capensis* (3) black rat *Rattus rattus* (5); common otter Lutra lutra (1); long-eared hedgehog *Hemiechinus auritus* (21); black bird *Turdus merula* (2); crested lark *Galerida cristata* (3), and grey hypocolius *Hypocolius ampelinus* (3) . General study area (fig. 1): The 10 provinces included in the present study are situated in its majority of areas lies within the Tigris-Euphrates alluvial salt marsh (PA0906) [41]. Although this area is surrounded by desert and shrub lands, but it is characterized by presence of marshes and plains with seasonal flooding in a basin covered by modern silty deposits occurred during Pleistocene and Holocene producing a wide inner delta of rivers Euphrates, Tigris and Karoon, a place in which the water of Turkey, Syria, Iraq and the western mountains of Iran coalesces before entering the Arabian Gulf [41]. Only small parts of South Iran Nubo-Sindian Desert and Semi-Desert (PA1328) extend into the Iraqi border area. The present study area is confined approximately within 44˚-48˚ longitude and 30˚-33˚ latitude, and represents a large basin of alluvial plain of Rivers Tigris and Euphrates which is extremely flat with slope degree of only 1m for every 10km on a distance of 600km from its northern to southern parts [42].

The climate of the area is considered continental to subtropical [43]. The annual precipitation maps showed that the mean slowly but steadily increased with the south-west to north-east direction. The mean annual precipitation in the study area is 60-200mm fluctuated from year to another and the temperature exceeds 50˚C in summer and rarely drops below 0˚C during winter with an annual mean of 22.4-25.6˚C [44].

The means of summer temperature ranges between 34-36˚C, while they are 8.8-12.2˚C for winter with a general mean relative humidity of 37-51%. The zoogeographical distribution of animals in the middle and south of Iraq related to Palaearctic region (Realm) with presence of two small extensions at extreme south of the area related in some of their animal components to the Ethiopian region near the Iraqi-Saudi borders and to the Oriental region near Fao town [29]. The plant cover of the area is related to the Desert Region, Sub-desert zone except for a narrow stripe at Iraqi-Iranian borders with Wasit and Missan provinces which related to Steppe region, Dry Steppe zone [42]. Some aquatic plants like *Phragmites australis* and *Typha angustifolia* dominate the area.

The area is considered endangered/critically endangered due to wide range changes to the ecosystem resulting from the desiccation of marshes in southern Iraq [45], especially during the 90s decade of the 20th century.

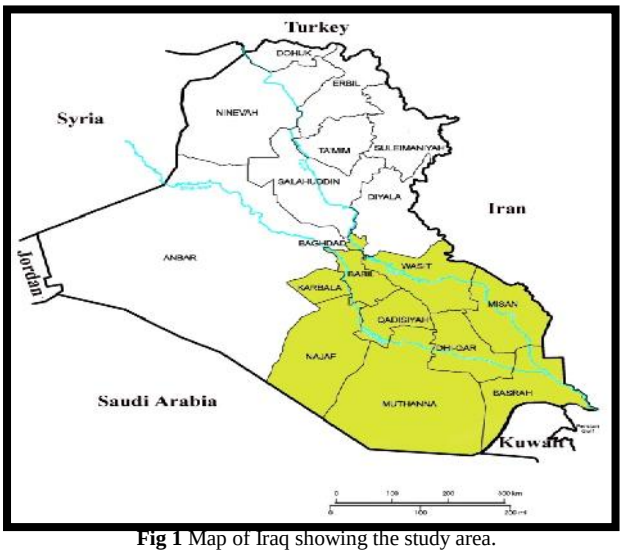

Fig 1 Map of Iraq showing the study area.

RESULTS

Table 1 summarizes the results on examination of domestic and wild animals in the middle and south of Iraq. It would show that the total infestation rate is 46.73% since 959 out of 2052 hosts examined were found infested with one or more ixodid tick species. In regard to host infestation rates among domestic animals, camels attain the highest infestation rate of 65.77%, then dogs (56.25%), horses (50%), cows (47%). Sheep (46.9%), water buffaloes (42.15%), goats 25.94%, donkeys (20%) and domestic cats (4.87%). In regard to infestation rates in wild animals, red foxes, Asiatic jackals and common otter were with 100% rate, followed by wild hares (81.25)%, long-eared hedgehog (76.19%), wild boar and wild jungle cat (66.66%), black bird (50%), ratel, crested lark and grey hypocolius (33.33%), and black rat (20%). It shows also that 13 ixodids identified to species level are present in the area along with 2 identified only to genus level.

Table 1 common name, no. examined, no. infested and infestation rate of hosts and the tick species infest hosts

Host	No. exam.	No. infest.	%	Tick species*
Cow	534	251	47	1,2,4,5,7,9,12,15
Buffalo	223	94	42.15	1,2,3,5,7,12,
Sheep	597	280	46.9	1,3,4,7,9,12,
Goat	212	55	25.94	1,12,
Horse	10	5	50	1,
Donkey	5	1	20	1,
Camel	336	221	65.77	1,2,3,4,5,6,7,9,
Dog	16	9	56.25	11,12
Domestic cat	41	2	4.87	12
Hare	16	13	81.25	10,12,13
Red fox	4	4	100	10,11
Asiatic jackal	14	14	100	12
Long-eared hedgehog	21	16	76.19	8,10,12
Wild jungle cat	3	2	66.67	12,14
Common otter	1	1	100	12
Wild boar	3	2	66.67	12
Ratel	3	1	33.33	12
Black rat	5	1	20	8
Black bird	2	1	50	8
Crested lark	3	1	33.33	8
Grey hypocolius	3	1	33.33	8

*1= *Hyalomma anatolicum*, 2= *Hyalomma dromedarii*, 3= *Hyalomma excavatum*, 4= *Hyalomma impeltatum*, 5= *Hyalomma scupense*, 6= *Hyalomma schulzei*, 7= *Hyalomma turanicum*, 8= *Hyalomma* sp., 9= *Rhipicephalus* (*Boophilus*) *annulatus*, 10= *Rhipicephalus leporis*, 11= *Rhipicephalus sanguineus*, 12= *Rhipicephalus turanicus*, 13= *Rhipicephalus* sp., 14= *Haemaphysalis adleri*, 15= *Haemaphysalis sulcata*.0

The most common species in regard to infestation rate in this study is *Hyalomma anatolicum* with an overall infestation rate among the different hosts of 30.59%. It infests buffaloes, horses, cows, sheep, donkeys, camels, and goats. In the second rank comes *Rhipicephalus turanicus* with total infestation rate of 18.03%. it infests buffaloes, sheep, cows, domestic cats, dogs, wild hares, Asiatic jackal, long-eared hedgehog, wild boars, red foxes, common otter, and ratel. H. *turanicum* comes third with 12.12% and found to infest camels, cows, sheep and buffaloes. *H dromedarii* is with 8.97% infestation rate. It is found to infest camels, buffaloes, and cows. Then comes *R. annulatus* with 7.74%. The rest are with relatively low infestation rate.

Only 4 specimens of *Haemaphysalis sulcata* are recorded from water buffaloes in Amara area, south of Iraq and this record is believed to be a new host record (fig.2).

Fig.2 A dorsal view of *Haemaphysalis sulcata*.

Haemaphysalis adleri which is recorded from wild jungle cat only and in dense vegetation habitats (table 2).

DISCUSSION

The present study differs from the previous tick studies in that it is devoted to the middle and south regions of Iraq, an area constitutes relatively a homogenous ecoregion; and it encounters examination results of ixodid ticks from a large number of domestic and wild mammals and birds.

An overall infestation rate of 47.5% is in general agreement with [26,34,46,47,48] who found nearly same results in dogs, cattle, and sheep. It disagree with [38,39,40] who found either found either much less or much higher infestation rates in sheep, goat and cattle. These results may reflect the fluctuation in the infestation rates among years and collection sites mostly due to climatic factors [49].

Among domestic animals, camels attain the highest infestation rate with 65.77%. This is in agreement with [37] who found close result in Al-Qadisiya province. Hoogstraal [9] called the camel as the "tick hunter's best friend". It travels through deserts, semi-deserts, cultivated areas, villages and towns and could acquire many different tick species through this tour. In addition, camel is with a delicate thin skin in some body area between thighs, udder and around anus with or without short hair which are preferable for tick's attachment. Infestation rates of other animals look close to each other at 40-50% except for goats and donkey which are with 25.94% and 20% respectively, while stray cats attains only 4.87%. These results reflect rather bad breeding practices for most domestic animals in the middle and south of Iraq, and agree with the findings of [29,50].

Among wild animals, the red fox and Asiatic jackal are with 100% infestation rate. This is rather not surprising since their meal list counts 31 species of reptiles, birds and small mammals which constitute potential hosts for immature stages of ticks [26,29,31,51]. The common otter is with 100% infestation rate also, but this result cannot be relied upon since only one specimen was examined. This animal is of aquatic living nature and expected to gain least burden of ectoparasites. Wild hare and long-eared hedgehog are with

Table 2 Species, hosts and collection sites for ixodid ticks of domestic and wild animals in the middle and south of Iraq

Tick species	Hosts *	Collection sites**
Hyalomma anatolicum	1,2,3,4,5,6,7	1,2,3,4,5,6,7,8,9,10
Hyalomma dromedarii	1,2,7	1,2,3,5,6,7
Hyalomma excavatum	2,3,7	2,4,5,6,7,8,9,10
Hyalomma impeltatum	1,3,7	3,5,6
Hyalomma scupense	1,2,7	1,5,8
Hyalomma schulzei	7	5,6,7
Hyalomma turanicum	1,2,3,7	1,5,8,10
Hyalomma sp.	1,2,3,4,14,16,17,19,20,21	1,2,3,4,5,6,7,8,9,10
Rhipicephalus (*Boophilus*) *annulatus*	1,2,3,5,6	1,2,5,6,7,8,10
Rhipicephalus leporis	10,11,12,13,17	1,4,9
Rhipicephalus sanguineus	8,11	9
Rhipicephalus turanicus	1,2,3,4,8,9,10,12,14,15,17	1,2,3,4,5,6,7,8,9,10
Rhipicephalus sp.	13	1
Haemaphysalis adleri	11,12,13	1
Haemaphysalis sulcata	2	8

*1=Cow, 2=Buffalo, 3=Sheep, 4=Goat, 5=Horse, 6=Donkey, 7=Camel, 8=Dog, 9=Domestic cat, 10=Hare, 11=Red fox, 12=Asiatic jackal,13=Wild jungle cat, 14=Wild boar, 15=Ratel, 16-Black rat, 17=Long-eared hedgehog, 18=Common otter, 19=Black bird, 20=Crested lark, 21=Grey hypocolius.
**1=Baghdad, 2=Babil, 3=Kerbala, 4=Wasit, 5=Diwaniya, 6=Najaf, 7=Muthana, 8=Missan, 9= Thi Qar, 10=Basra.

In general, tick species have no clear distribution pattern on both hosts and collection areas, except for *Hyalomma schulzei*, and for a lesser extent *H. dromedarii* which show a kind of specificity to camel hosts and in desert areas; and also

This is in accordance with [26,52]. They found almost same results in the middle of Iraq.

In regard to tick species recorded in this study, 13 species belong to 3 genera *Hyalomma*, *Rhipicephalus*, and *Haemaphysalis* are present in the study area. The present results agrees with [18-24,26,29], but disagrees with [34] who found *Hyalomma rufipes* and *H. truncatum* dominant in Thi Qar province, south of Iraq. Both of these ticks were not previously reported to be present in Iraq and we cannot find them in any location in the middle and south of Iraq although of the intensive collection in the region. However, [53,54] recorded *H. rufipes* from Turkey, Iran, Syria and Saudi Arabia. *Hyalomma truncatum* is of African origin except for a rare record in Yemen and southwest of Saudi Arabia [55].

Ticks belong to genus *Hyalomma* are the dominant in the present study and constitute the most diverse group, both in the number of species (7 spp.) and in the number of individual ticks collected. Kolonin [56] referred to acclimation of *Hyalomma* members to the environment of the area and availability of shelters of plant cover components to larvae and nymphs as well as the high adaptation for hot, arid and open habitats as reasons for the successful dispersion. Genus *Rhipicephalus* with 4 species ranked second while *Haemaphysalis* with 2 species was the least dispersed ticks among hosts and collection sites. This is in accordance, also, with [57,58]. Results show that *Hyalomma anatolicum* is the dominant species among other species of *Hyalomma* as well as species of the another two genera among the domestic animals. It infests cows, buffaloes, camels, sheep, goats, horses, donkeys, and from the soil in some collection sites, but it does not infest any wild animal. It was collected in the whole study area. Then comes *H. turanicum*, *H. dromedarii*, *H. scupense*, *H. schulzei*, *H. excavatum*, and *H. impeltatum* respectively. These results agree with [18,20,21,26,29,56,59,60].

Rhipicephalus ticks comprise 4 species, among them *R. turanicus* is wide spread among domestic and wild hosts in most of collection sites, and comes after *H. anatolicum* in prevalence in the study area. It was recorded from buffaloes, cows, domestic cats, dogs, sheep, goats, wild hares, red foxes, Asiatic jackals, long-eared hedgehog, wild boar, common otter, and ratel. [29] referred this wide distribution to its tolerance to a wide temperature scale which is may be related, partly at least, to its African origin. It was first recorded in Iraq by [26], then after it was frequently reported from south region [29,50], from middle region [36,61,62] and from western and northern parts of Iraq [51,63,64]. However, it appears from the present and previous findings that *R. turanicus* is almost equally linked to both wild and domestic hosts. Also, *R. sanguineus* is reported from dog (domestic) and red fox (wild) but with very low rate, which agrees with [26,29]. *R.* (*Boophilus*) *annulatus* is reported from some domestic animals only including buffaloes, cows, sheep, goats, and camels. Our results agree with [26] who found it on domestic animals in whole Iraq. *R. leporis* is recovered from wild hosts only including wild hares, red foxes, and long-eared hedgehog. It was first recorded by [26], then reported later by [29] from wild hosts.

The least distributed genus is *Haemaphysalis* which encounters 2 species, *Haem. adleri* which is recovered from wild jungle cat and red fox, a result coincides with [26,29]. The second species is *Haem. sulcata* which is recovered from a water buffalo in Missan province. Shubber [65] recorded this result and considered it to be a new host record for this tick.

According to the current results, some species showed a high degree of host specificity. Infestation with *Hyalomma schulzei* is confined to camels only, while *Hyalomma dromedarii* infests mainly camels with sporadic records from other hosts. Also, infestation with *Haemphysalis adleri* and *Rhipicephalus sanguineus* are linked to a very few host species. On the other hand, some ticks showed no host specificity like *H. anatolicum* and *R. turanicus*. This is in general accordance with [9,23,26,29,30,35,66].

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