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HARD TICKS (ACARI: IXODIDAE) INFESTING ARABIAN CAMELS (*CAMELUS DROMEDARIUS*) IN MEDINA AND QASSIM, SAUDI ARABIA

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KEY WORDS

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Ticks
Hyalomma, Prevalence
Medina
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ABSTRACT

Ixodid ticks are hematophagous obligatory ectoparasites that occur worldwide and transmit pathogens to humans and other vertebrates, causing economic livestock losses. The Arabian camel (*Camelus dromedarius* Linnaeus, 1758) is an important livestock animal in Saudi Arabia that is vulnerable to parasitism by ticks. The diversity and intensity of ticks on Arabian camels in certain localities in the Medina and Qassim regions of Saudi Arabia were determined. One hundred forty camels were examined for ticks, and 106 were infested (98 females, 8 males). A total of 452 ixodid ticks (267 males, 185 females) were collected from the infested Arabian camels. The tick infestation prevalence was 83.1% and 36.4% in female and male camels, respectively (female camels harbored significantly more ticks than did male camels). The recorded tick species were *Hyalomma dromedarii* Koch, 1844 (84.5%); *Hyalomma truncatum* Koch, 1844 (11.1%); *Hyalomma impeltatum* Schulze and Schlottke, 1929 (4.2%); and *Hyalomma scupense* Schulze, 1919 (0.22%). *Hyalomma dromedarii* was the predominant tick species in most regions, with a mean intensity of 2.15 ± 0.29 ticks/camel (2.5 ± 0.53 male ticks/camel, 1.8 ± 0.21 female ticks/camel). The proportion of male ticks was higher than that of female ticks (59.1 vs. 40.9%). To the best of our knowledge, this is the first survey of ixodid ticks on Arabian camels in Medina and Qassim, Saudi Arabia.

Because of its extraordinary ability to thrive in arid environments with scant vegetation, the one-humped Arabian camel (*Camelus dromedarius* Linnaeus, 1758) is an important livestock animal in Saudi Arabia. It is believed that Saudi Arabia has the largest camel population in the Arabian Peninsula, with a camel population of approximately 1.6 million (Abdallah and Faye, 2012). Camels are valuable animals due to their meat, milk, and leather resources (Alanazi et al., 2018a). Camels are multipurpose animals that thrive under arid and semiarid conditions because of their unique adaptive physiological and structural characteristics. Camels also support tourism and are used in sports and for transportation through deserts and rural areas.

The Arabian camel is vulnerable to various ectoparasites. Among them, several species of ticks infest camels in many Arabian countries, including Saudi Arabia (Al-Kahlifa et al., 1985; Diab et al., 1987, 2006; Alanazi et al., 2018a).

Ixodid ticks are hematophagous obligatory ectoparasites worldwide, and they are well-known vectors of different pathogens that infect humans and other vertebrates, causing a variety of diseases (Hoogstraal et al., 1981; Papadopoulos et al., 1996; Aktas et al., 2004; Jongejan and Uilenberg, 2004; Estrada-Peña and Santos-Silva, 2005; Salim Abadi et al., 2010; Apanaskevich and Oliver, 2013; Yu et al., 2015; Azagi et al., 2017, Coronel-Benedett et al., 2018; Estrada-Peña et al., 2018; Mamman et al., 2021; Omeragić et al., 2022). In comparison with other blood-sucking arthropods, hard ticks feed for a longer period (Sonenshine, 1991; de la Fuente et al., 2017) which, in turn, increases the probability of pathogen transmission (Richards et al., 2017). Tick bites can cause symptoms such as irritation, dermatitis, fatigue, paralysis, and malnutrition; moreover, severe infestations can cause anemia, weight loss, and even death due to exsanguination (Al-Kahlifa et al., 1985; Bock et al., 2004;

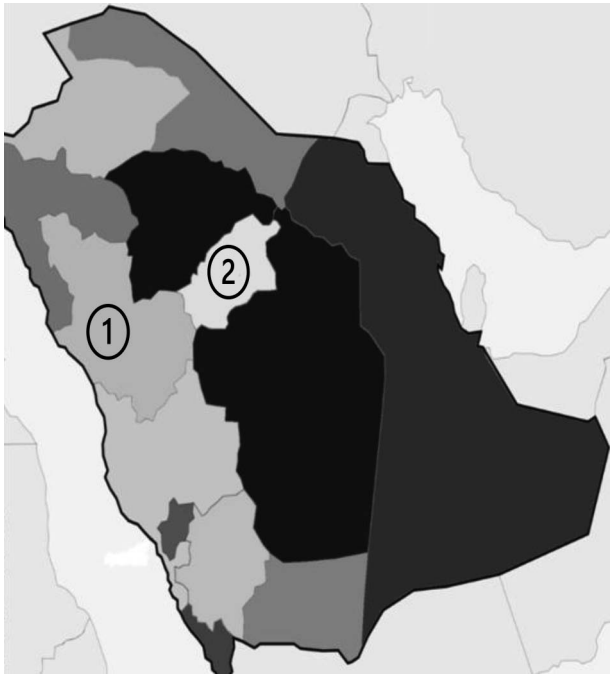

Figure 1. A map of Saudi Arabia showing Medina (1) and Qassim (2) regions.

Jafarbekloo et al., 2014; Sofizadeh et al., 2014; Mansfield et al., 2017).

Ticks represent the second most important prevalent disease vectors after mosquitoes and transmit pathogens to more than 100,000 humans per year (de la Fuente et al., 2008). It was reported in the United States, in the period from 2000 to 2010, that there were more than 250,000 human cases of Lyme borreliosis; and more than 85,000 cases were also reported in Europe (Sood et al., 2011). In addition to Lyme disease and Rocky Mountain spotted fever, pathogens that cause diseases such as theileriosis, babesiosis, human anaplasmosis, tick-borne encephalitis (TBE), and relapsing fever are transmitted by ticks (Dumler et al., 2005; Bakken and Dumler, 2008; Jaenson et al., 2012; Meng et al., 2014; Brites-Neto et al., 2015). Camels have been reported to be infected with some tick-borne pathogens such as *Anaplasma platys*, *Anaplasma phagocytophilum*, *Anaplasma* sp., *Ehrlichia canis*, and *Hepatozoon canis* in Riyadh (Alanazi et al., 2020). Additionally, tick-borne bacteria infecting camels (*Candidatus Anaplasma camelii*, *Candidatus Ehrlichia regneryi*, and *Coxiella burnetiid*) were also recorded by Getange et al. (2021).

Previous studies have revealed that some domestic animals in Saudi Arabia are vulnerable to infestations by many ticks (Al-Asgah, et al., 1985; Diab et al., 2006), with the most frequent tick species belonging to the genera *Hyalomma* and *Rhipicephalus*. *Hyalomma dromedarii* Koch, 1844 is the most common tick species infesting camels in Saudi Arabia, according to these studies.

Current control strategies for ticks on farm facilities in Saudi Arabia are either nonexistent (by small-scale growers) or depend on the application of specific acaricides (Walker et al., 2003; Al-Afaleq et al., 2018).

The aim of the present study was to fill the knowledge gaps in the diversity and intensity of ticks infesting camels in certain regions of Saudi Arabia, i.e., Medina and Qassim.

MATERIALS AND METHODS

Collection sites

Specimens were collected from 5 localities in Medina (Fig. 1), namely, the Central region (24°28′55″N, 39°37′30″E), Al Baidha (24°40′55″N, 39°26′36″E – 28.5 km northwest to the central region), Al Mindassah (24° 37′58″N, 39°18′11″E – 34 km northwest to the central region), Al Furaysh (24°14′53″N, 39°16′17″E – 42 km southwest to the central region), and Abu Al Dood (24°41′26″N, 39°29′ 6″E – 27 km northwest to the central region), and from 2 localities in Qassim, Buraydah: Al Saqarat (26°19′00″N, 43°54′22″E – 481 km east to the central region) and Al Rashdyat (26°28′10″N, 44°03′34″E – 501 km east to the central region), Saudi Arabia, from October 2020 to April 2021; because the weather at this time is the most suitable (average temperature: 15–30 C), this period is considered the best sampling time.

Collection and identification of specimens

Surveyed Arabian camels (*Camelus dromedarius*) were from private farms, and verbal consent was obtained from the farm owners before tick collection. A brief verbal explanation was also given to the owners about the collections and that no harm would affect their camels. All examined camels were adults, with nearly similar sizes, especially females. Males were larger than females. The camels were kept in small groups (mostly less than 10) and camels were roaming for a short distance around the farm (approximately 1–2-km range). The camels' hair was short to moderate in length with beige color. The husbandry practices are relatively standard among camel farms.

Ticks were collected from infested camels using forceps. Ticks were localized on specific body parts of camels such as the perineum, chest, and upper areas between forelegs and hind legs. Ticks were collected from all infested camels on each visited farm (each camel was examined for approximately 15 min).

Collected ticks were placed in plastic containers with 70% ethanol. All containers were labeled directly after sampling with locality, host sex, and date information. Ticks were then transported to the Laboratory of Entomology and Parasitology, Department of Biology, College of Science, Taibah University, Saudi Arabia for further investigation. All collected ticks were kept in the same laboratory as reference specimens. Tick species were identified using a binocular microscope (Krüss, Germany) according to the identification keys (Walker et al., 2003; Estrada-Peña et al., 2018).

Data analysis

Data analysis was performed using Microsoft Excel Worksheet (Microsoft Office 365) (Microsoft, Redmond, Washington) and Minitab 17 (Minitab, Inc., State College, Pennsylvania) to calculate the mean intensity (mean number of ticks per infested camel), the standard error of the mean (SE), and the difference among tick infestations in camels using a 2-sample *t*-test. The prevalence of infestation and the mean intensity of ticks were determined using the following formula (Gharbi et al., 2013).

Table I. Number and prevalences of male (M) and female (F) camels infested with *Hyalomma* spp. in different localities in Saudi Arabia.

Region	No. of camels		No. of infested camels		Total infestation prevalence (%)	Infestation prevalence by sex (%)		*Hyalomma* spp.
	M	F	M	F		M	F	
Al Baidha	3	21	2	21	95.8	66.7	100	*H. dromedarii*
	0	1	0	1	100	0	100	*H. scupense*
Al Mindassah	2	26	0	26	92.9	0	100	*H. dromedarii*
Abu Al Dood	1	9	0	9	90	0	100	*H. dromedarii*
Al Furaysh	3	12	0	12	80	0	100	*H. truncatum*
Central region of Medina	4	28	2	21	71.9	50	75	*H. dromedarii*
	3	15	0	2	27.8	0	13.3	*H. dromedarii*
								H. impeltatum
				3			20	*H. impeltatum*
Buraydah (Al Saqarat & Al Rashdyat)	6	6	4	3	58.3	66.7	50	*H. dromedarii*
Total	22	118	8	98	75.7	36.4	83.1	

$$\text{Prevalence of camel infestation} = \frac{\text{Number of infested camels}}{\text{Number of examined camels}} \times 100.$$

$$\text{Mean intensity of ticks} = \frac{\text{Number of ticks}}{\text{Number of infested camels}}.$$

RESULTS

Overall, 140 camels were examined for ticks. Female camels were significantly more vulnerable to tick infestation than were males ($P < 0.01$), with prevalences of female and male camels being 83.1% and 36.4%, respectively (Table I). However, prevalences of infested female and male camels were 92.4% and 7.5%, respectively. The number of ticks per camel ranged from 1 to 48 (mean 2.5 ± 0.5 male ticks/camel and 1.8 ± 0.2 female ticks/camel).

Among the collection sites, in Al Baidha, prevalences of infested female and male camels were 100% (22 females) and 66.7% (2 males), respectively. In Al Mindassah, all infested camels were females, and no infestation was reported in males. In Abu Al Dood and Al Furaysh, prevalences of camel infestations were the same as those in Al Mindassah. In the central region of Medina, prevalences of infested female and male camels were 60.5% and 28.6%, respectively (Table I).

In Buraydah, Qassim, ticks were collected from 2 localities, Al Saqarat and Al Rashdyat, and the prevalence rate of infested female camels was 50%; however, the prevalence rate of infested male camels was 66.7%. The maximum number of ticks per camel was recorded from Buraydah on a female camel infested with 38 male and 10 female ticks. These ticks were all identified as *H. dromedarii* (Tables I, II).

All collected ticks were identified as 4 species: *Hyalomma dromedarii* Koch, 1844; *Hyalomma scupense* Schulze, 1919; *Hyalomma impeltatum* Schulze and Schlottke, 1930; and *Hyalomma truncatum* Koch, 1844. Overall, the number of male ticks was higher than the number of female ticks. The predominant species was *H. dromedarii* (n = 382, 84.5%, 223 males and 159 females), followed by *H. truncatum* (n = 50, 11.1%, 25 males and 25 females), *H. impeltatum* (n = 19, 4.2%, 18 males and 1 female) and *H. scupense* (n = 1, 0.2%, 1 male) (Fig. 2).

Both *H. dromedarii* and *H. scupense* were collected in Al Baidha. *Hyalomma dromedarii* was the predominant tick species, with a proportion of 98.3%; the proportion of *H. scupense* was 1.7%. In the Al Mindassah and Abu Al Dood regions, all collected ticks were identified as *H. dromedarii*. In the Al Furaysh

Table II. *Hyalomma* spp. from different localities in Saudi Arabia. The number and proportion (%) of male (M) and female (F) ticks are shown. SE: standard error of the mean.

Region	No. of infested camels	*Hyalomma* spp.	Tick sex and no. (%)		Total no. of ticks (%)	Mean intensity ± SE (range)	
			M	F		M	F
Al Baidah	23	*H. dromedarii*	24 (41.1)	34 (58.6)	58 (98.3)	1.1 ± 0.1 (0–6)	1.5 ± 0.3 (0–4)
	1	*H. scupense*	1 (100)	0 (0)	1 (1.7)	1.0	0.0
Al Mindassah	26	*H. dromedarii*	44 (53.7)	38 (46.3)	82 (100)	1.7 ± 0.5 (0–7)	1.5 ± 0.4 (0–5)
Abu Al Dood	9	*H. dromedarii*	17 (56.7)	13 (43.3)	30 (100)	1.9 ± 1.0 (0–8)	1.5 ± 0.4 (0–3)
Al Furaysh	12	*H. truncatum*	25 (50)	25 (50)	50 (100)	2.1 ± 0.6 (0–5)	2.1 ± 0.4 (0–4)
Central region of Medina	23	*H. dromedarii*	43 (46.7)	49 (53.3)	92 (74.2)	2.1 ± 0.4 (0–6)	2.3 ± 0.5 (0–10)
	2	*H. dromedarii*	12	1	13 (10.5)	6.0 ± 2.0 (4–8)	0.5 ± 0.5 (0–1)
		H. impeltatum	11 (92.3)	0 (7.7)			
	3	*H. impeltatum*	7 (94.7)	1 (5.3)	19 (15.3)	3.6 ± 1.8 (0–10)	0.2 ± 0.2 (0–1)
Buraydah	7	*H. dromedarii*	83 (77.6)	24 (22.4)	107 (100)	11.9 ± 5.2 (0–38)	3.4 ± 1.4 (0–10)
Total	106		267 (59.1)	185 (40.9)	452 (100)	3.5 ± 1.2 (0–38)	1.4 ± 0.4 (0–10)

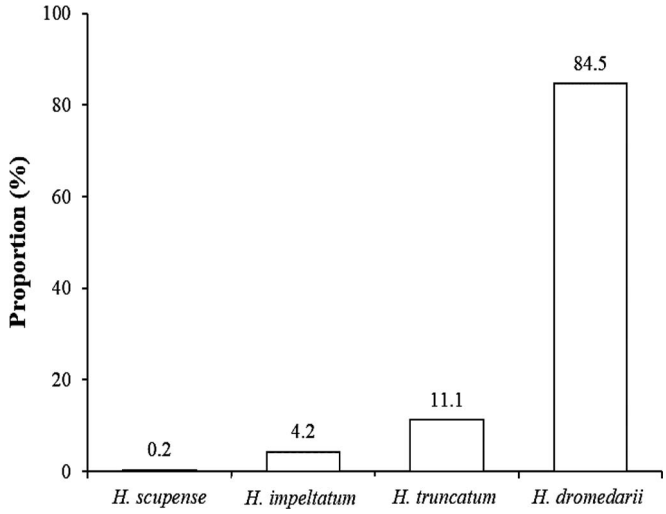

Figure 2. Proportion of different *Hyalomma* spp. infesting camels.

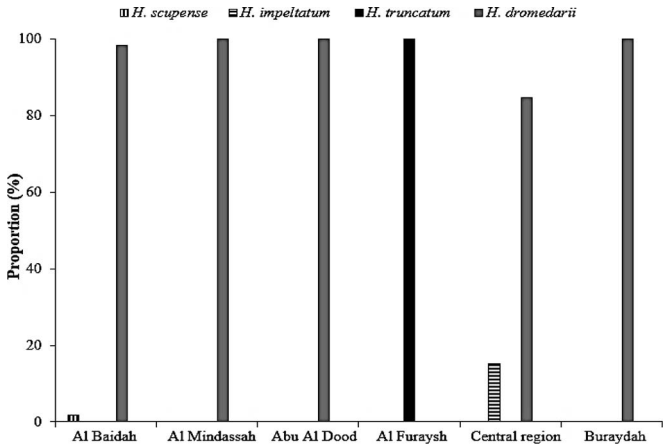

Figure 3. Proportion of different *Hyalomma* spp. infesting camels from different localities.

region, all collected ticks were identified as *H. truncatum*. In the central region of Medina, *H. dromedarii* and *H. impeltatum* were collected; *H. dromedarii* was the predominant tick species, accounting for 84.7% of all collected ticks, while *H. impeltatum* accounted for only 15.3%. In Buraydah, all recorded ticks were identified as *H. dromedarii* (Fig. 3; Table II).

Dual infestation was recorded for only 2 female camels that were infested with both *H. dromedarii* and *H. impeltatum*. The total numbers of *H. dromedarii* and *H. impeltatum* were 13 (12 males and 1 female) and 11 (males only), respectively.

DISCUSSION

Arabian camels (*C. dromedarius*) were examined for ticks and 75.7% were found to be infested with one or more of the following 4 species of ixodid ticks: *H. dromedarii* (84.5%), *H. truncatum* (11.1%), *H. impeltatum* (4.2%), and *H. scupense* (0.2%).

The current results are similar to those of Elghali and Hassan (2009), who studied hard tick-infested camels in northern Sudan and found the predominant tick species to be *H. dromedarii*, with an 88.9% prevalence. They also reported the prevalence of *H. impeltatum* to be 7.7%. These proportions are comparable (*H. dromedarii* [84.5%] and *H. impeltatum* [4.2%]) to those in the present study. These similarities may be due to the similar climatic conditions between Saudi Arabia and Northern Sudan. A similar percentage of *H. dromedarii* (84.7%) was also recorded from infested camels in Iran (Fard et al., 2012). Other studies have reported the predominance of *H. dromedarii*, which was observed in the present study (Diab et al., 2006; Nabian et al., 2009; Salim Abadi et al., 2010; Gharbi et al., 2013).

Notably, *Hyalomma* spp. (Apanaskevich and Horak, 2009) collectively have a very wide distribution, covering India; the Middle East and Central Asia; the Arabian Peninsula; North, Central, and East Africa; as well as parts of West Africa (Estrada-Peña et al., 2018; Perveen et al., 2021). Hoogstraal et al. (1981) reported that in parts of Europe *H. dromedarii* is active all year long and principally occurs in desert and semidesert habitats.

Hyalomma dromedarii is widespread in the Middle East and North Africa (Egypt and Northern Sudan) and central and southeast Asia (Hoogstraal et al., 1981; van Straten and Jongejan, 1993; Diab et al., 2001; Elghali and Hassan, 2009). *Hyalomma dromedarii* is also abundant in Saudi Arabia (Al-Khalifa et al., 1983, 1987; Diab et al., 1987; Morel, 1989; van Straten and Jongejan, 1993; Diab et al., 2006; Gharbi et al., 2013; Alanazi et al., 2018b), as *H. dromedarii* ticks are highly adapted to desert ecosystems. The environment of Saudi Arabia is appropriate for the rapid dissemination of numerous tick species due to its wide range of climatic conditions (Alanazi et al, 2018b). A variety of tick species were reported by Alanazi et al. (2018b), such as *H. dromedarii* (most abundant), followed by *H. impeltatum*, *Hyalomma anatolicum*, and *Rhipicephalus turanicus*; and as in the present investigation, the number of male ticks collected was higher than the number of female ticks.

Most of the infested camels (99 out of 106) in this study were from different localities in Medina, as Medina belongs to a climatic zone that is hot and humid, with sparse precipitation. Medina is in the subtropical zone and Mediterranean subzone and has mountainous topography (Zuhairy and Sayigh, 1993; Alrashed and Asif, 2015). A warm climate may increase the survival rate of ticks, shorten their life cycles, and prolong the period of tick activity (Ogden et al., 2021). In contrast, the Qassim region has a desert climate, with cool, rainy winters and hot, relatively dry summers, so the smaller number of ticks collected in this region may be related to these climatic conditions (Al-Wabel et al., 2020).

In the current investigation, the number of infested female camels exceeded that of infested males, as the numbers of infested females and males were 98 and 8, accounting for infestation prevalences of 92.4% and 7.5%, respectively. The same trend was recorded by Elghali and Hassan (2009), who reported that female camels harbored more ticks than did male camels. The larger number of infested female camels could be attributed to pregnancy and lactation stress, which may decrease the resistance of females to tick infestation (Ali, 2004). Similar results were reported by Hassan (1997), who found that cows had higher infestation loads of *Rhipicephalus appendiculatus* and *Amblyomma variegatum* than did oxen. Another possible explanation is that the number of male camels is less than the number of female camels on farms, as the purpose of the presence of males on a farm is to mate with females; therefore, due to the sex ratio on

farms, the number of infested females exceeds the number of infested males.

It was also observed that the number of male ticks was larger than the number of female ticks, with proportions of 59.1% and 40.9%, respectively, during the collection period. The same pattern of male tick dominance on hosts was also observed by Hoogstraal, (1956), Elghali and Hassan (2009), and Fard et al. (2012). The higher male-to-female tick sex ratio may be related, as noted by Hoogstraal (1956), to the fact that females leave the host after a few days of feeding to oviposit, while males remain on the host for up to a few weeks before dislodging.

This study suggested that camels infested with ticks, especially in different localities of Medina, may be related to climatic changes (Sanchez-Vicente et al., 2019; Ogden et al., 2021) and may be due to inadequate farm management and low awareness among farmers. This may necessitate quick prevention and control interventions in the surveyed locations.

CONCLUSION

For successful tick control, awareness among livestock owners, the reasonable use of acaricides, and the development of eco-friendly tick-control alternatives should be implemented. Future studies are needed to elucidate the characteristics of other tick-endemic localities within Saudi Arabia during different seasons to obtain a complete picture of the status of ticks infesting camels in Saudi Arabia. This will allow the development of appropriate tick control measures to preserve the health of camels and prevent the transmission of tick-borne pathogens to humans and other vertebrates.

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