

The Distribution, Host Range and Seasonal Abundance of the Arabian Goat and Sheep Tick, *Boophilus kohlsi* (Acari: Ixodidae) in Saudi Arabia*

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ABSTRACT. The host range, seasonal abundance and distribution of the Arabian goat and sheep tick, *Boophilus kohlsi* were investigated in several localities throughout the Kingdom of Saudi Arabia. The tick was found in two regions in the Kingdom: along the central and southern parts of the Arabian Gulf Coast of the Eastern Province and in the Al-Sarawat Mountains Range in Makkah Province. In both regions, *B. kohlsi* was found parasitizing goats only, on which it coexists with *Rhipicephalus turanicus* and sometimes with both *R. turanicus* and *Hyalomma impeltatum*. In Makkah Province, the main partner of *B. kohlsi* on its goat hosts was *Hyalomma arabica*. The infestation of goats by *B. kohlsi* in both regions was seasonal and occurred only during the most humid months of the year, October to March, with a peak in January and February. The tick life cycle in both regions seemed to be influenced by variations in the relative humidity and can complete one or possibly two intergrading generations per annum or three generations every two years.

Boiophilus kohlsi Hoogstraal and Kaiser 1960 is morphologically related to *Boophilus decoloratus* Koch 1844 of the humid parts of the Ethiopian Faunal Region and, unlike other boophilids (cattle ticks), it prefers sheep and goats and inhabits comparatively arid parts of the World (Hoogstraal and Kaiser 1960, Hadani *et al.* 1964, and Hoogstraal *et al.* 1981). The tick was first described from specimens collected from sheep and goats between the Sea of Galilee and The Dead Sea in Jordan by Hoogstraal and Kaiser (1960). Since then, it was collected, especially from goats, in these and other areas of the Jordan Valley, as well as from the Dohuk area of Mosul District of Iraq, from Ta'izz and Sana'a Districts of Yemen Arab Republic, from Syria and from Asir and Makkah Provinces of Saudi Arabia (Hadani *et al.* 1964, Banaja and Rosdhy 1978, Banaja *et al.* 1980, Hoogstraal *et al.* 1981, Pegram *et al.* 1982a, and Hoogstraal and Tatchell 1985).

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The present study is a part of 5-year nationwide tick programme initiated in the Kingdom of Saudi Arabia to determine the indigenous tick fauna of the Kingdom, their distribution, hosts and ecological relationships (Al-Khalifa *et al.* 1983, 1984, 1986, 1987, Hoogstraal *et al.* 1984, Al-Asgah *et al.* 1985, Al-Khalifa and Diab 1986, and Diab *et al.* 1987).

The present paper reports the distribution, host range and seasonal abundance of an almost unstudied tick species, *B. kohlsi* in the Kingdom.

Materials and Methods

Total monthly deticking of at least 10 camels, 10 cattle, 10 sheep and 10 goats randomly selected from local herds at each of the localities shown in Fig. 1 was undertaken during 1982/83 and 1984/85 (March to March). The collection sites at each locality were at a radius of about 100 km around each of the urban centres shown in Fig. 1 and these areas were carefully selected well away from any possible mixing between local and imported livestock. Moreover, during the period of study, ticks were also collected from a total of 25 horses sampled at Jazan and Najran centres (Fig. 1).

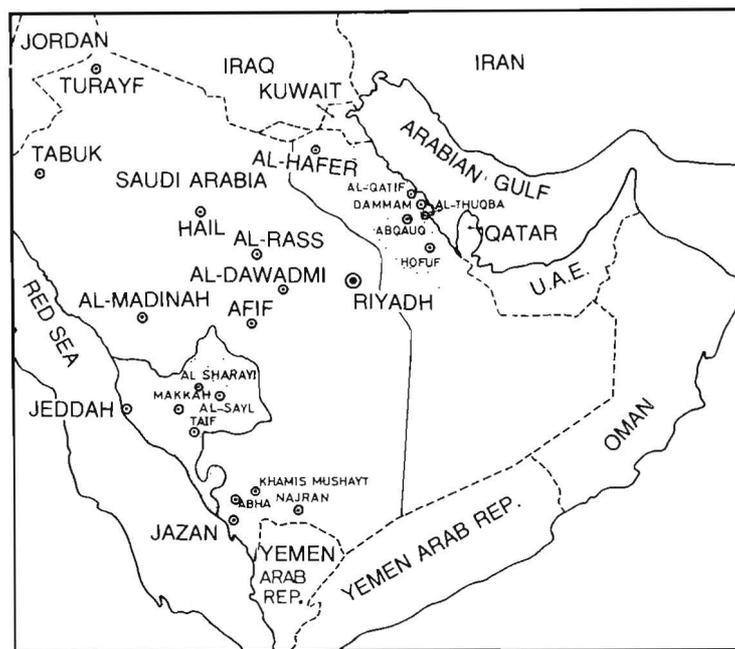


Fig. 1. The Arabian Peninsula with urban centres (all cities shown in the map) of tick collection sites in Saudi Arabia. Areas of distribution of *Boophilus kohlsi* are shaded.

The ticks were collected into vials (25 × 100 mm) containing 70% ethanol and were identified using the keys of Hoogstraal (1956), Hoogstraal and Kaiser (1959), (1960), Hoogstraal *et al.* (1981) and Pegram *et al.* (1982b). Our identifications were confirmed and commented upon by the late Dr. Harry Hoogstraal, Medical Zoology Department, United States Naval Medical Research Unit No. 3, Cairo, Egypt.

Results

During the period of study, *B. kohlsi* was collected only from goats in the localities shown in Table 2, all of which are in the Eastern and Makkah Provinces (Fig. 1). The tick was found on its goat hosts in these areas between October and March only, the most humid months of the year in both regions of its distribution (Table 1). During this period, the heaviest infestation occurred during January and February where the tick was well represented in all samples procured from all collection sites within its areas of distribution (Fig. 1, Table 2). However, between October and December, the tick infestation though meagre and patchy in these areas, yet the numbers were rising steadily from one month to another and by early January, the tick was detected in all sites sampled within its range of distribution (Fig. 1). During October, the tick was only represented in samples taken from goats at Taif (1 ♂, 2 ♀, 5 nymphs (N), Al-Sharayi (2 ♀) and Abqauq (1 ♂, 3 ♀, 25N). During November, it was found only in samples from Taif (2 ♂, 7 ♀), Al-Sharayi (1 ♂, 3 ♀), Abqauq (5 ♂, 11 ♀, 21N) and Dammam (9 ♂, 15 ♀, 35N), whilst during December a total of 115 ♂, 398 ♀ and 55N were collected from all sites within the areas of the tick distribution except Hofuf and Al-Sayl (Fig. 1). On the other hand during March, small numbers of engorged females were the only representatives of the tick and were taken from goats at Taif (2 ♀), Dammam (4 ♀), Abqauq (4 ♀) and Al-Thuqba (2 ♀). Despite vigilance in search for larvae, none were detected in any of the goats sampled.

Other tick species represented in the samples taken from goats together with *B. kohlsi* in both regions of its distribution were *Rhipicephalus turanicus* Pomerantzev and Matikashvili, 1940 and *Hyalomma impletatum* Schulze and Schlottko, 1930 but in Makkah Province, *Hyalomma arabica* Pegram, Hoogstraal and Wassef, 1982 was the main partner of *B. kohlsi* on their goat hosts (Table 2). Moreover, 15 ♀ *Hyalomma dromedarii* Koch, 1844 were also collected from goats at Dammam and 3 ♂, 3 ♀ *Hyalomma anatolicum anatolicum* Koch, 1844 at Al-Sayl.

Elsewhere in the Kingdom (see Fig. 1), the goats sampled at Turayf (Northern Frontier Region), Hail (Hail Province), Al-Rass (also from Buraydah, Unayzah, Al-Badaya and Riyadh Al-Khabra, all within a radius of about 100 km around Al-Rass in Qasim Province), Afif and Al-Dawadmi (Riyadh Province), Abha and

Table 1. Climatic parameters at Taif (Makkah Province) and Dammam and Hofuf (Eastern Province) during 1982/83, 1984/85*

Month	Mean Air Temperature °C (Maximum/minimum)			Mean relative humidity** %			Rainfall (mm)		
	Taif	Dammam	Hofuf	Taif	Dammam	Hofuf	Taif	Dammam	Hofuf
Jan	16/9.5	20.4/10.7	20.8/7.4	78	72	70	37.8	8.6	2.2
Feb	13.7/9.6	19.7/11.5	19.7/8.5	84	78	72	188.1	55	31.2
Mar	18.5/11.7	23/15.7	23.9/12.1	74	69	68	52.7	84	46.8
Apr	20.8/12	30.6/18.8	33.0/16.6	69	64	57	25.2	0.0	24.2
May	24/14.4	36.5/24.8	38.6/22	64	68	46	46.9	0.0	0.0
Jun	29.2/18.2	40.3/26.7	42.6/24.5	53	60	36	2.2	0.0	0.0
Jul	27.5/17.2	43.1/23.9	46/24	52	60	40	8.1	0.0	0.0
Aug	26.5/16	41.3/28	42.1/25.8	57	46	33	0.4	0.0	0.0
Sept	27/14.9	40.4/26.5	41.3/22.4	40	55	48	0.0	0.0	0.0
Oct	20.6/11.4	34.8/22.3	36.3/19	68	78	55	89.4	9.2	2.2
Nov	17/8.7	24/14.2	24.6/11.6	72	85	68	10.0	71.2	30.3
Dec	15.3/8.3	18.2/10.2	19.2/7.4	74	80	72	16.3	13.8	14.4

* Obtained from the Hydrology Division, Ministry of Agriculture and Water, Riyadh.

** Between October and February the maximum relative humidity within these areas is well above 90% and at Dammam, it reaches 100% for several days.

Table 2. Mean numbers of ticks infesting local goats in Eastern and Makkah Provinces of Saudi Arabia during January and February (1983 and 1985)

Province:	Locality	<i>Boophilus kohlsi</i>			<i>Hyalomma arabica</i>		<i>Hyalomma impeltatum</i>		<i>Rhipicephalus turanicus</i>		Total
		♂	♀	Nymphs	♂	♀	♂	♀	♂	♀	
Eastern:	Abqauq	15	68	80	0	0	3	8	56	75	305
	Al-Thuqba	17	24	15	0	0	0	0	35	23	114
	Al-Qatif	18	23	18	0	0	1	0	22	35	117
	Dammam*	24	85	75	0	0	3	10	52	78	327
	Hofuf	2	8	0	0	0	0	0	2	5	17
Makkah:	Al-Sayl**	3	0	0	97	106	2	0	81	97	394
	Al-Sharayi	4	0	0	2	2	0	0	0	0	23
	Taif	68	85	90	28	48	1	0	4	4	328
Total		151	316	278	127	156	10	18	252	317	1.625

* 15 ♂ *Hyalomma dromedarii* were collected from goats at Dammam.

** 3 ♂ and 3 ♀ *Hyalomma anatolicum anatolicum* were collected from goats at Al-Sayl.

Khamis Mushayt (Asir Province) and Najran (Najran Province) yielded no ticks. Whilst *R. turanicus* was collected from goats at Tabuk (Tabuk Province: 25 ♂, 35 ♀), Al-Madinah (Al-Madinah Province: 12 ♂, 8 ♀), Al-Hafr (Eastern Province: 15 ♂, 20 ♀) and Jazan (Jazan Province: 1 ♂, 2 ♀) (see Fig. 1). Moreover, goats sampled at Al-Hafr yielded 5 ♀ *H. impletatum*, 6 ♂ *H. a. anatolicum*, 10 ♂, 10 ♀ *Hyalomma anatolicum excavatum* Koch, 1844 and 30 *Hyalomma* species nymphs, those at Jazan 1 ♂, 1 ♀ *H. a. anatolicum* and those at Riyadh (Riyadh Province) 7 ♂, 10 ♀ *Rhipicephalus sanguineus* Latreille, 1806 (see Fig. 1).

Discussion

The present results indicate that in Saudi Arabia, *B. kohlsi* infests only goats and is widely distributed both along the central and southern parts of the Arabian Gulf Coast of the Eastern Province and in the Al-Sarawat Mountains of Makkah Province. Unlike in the Yemen Arab Republic, where the tick was collected throughout the year from both goats and sheep (Pegram *et al.* 1982a), the infestation of goats with *B. kohlsi* in its areas of distribution in Saudi Arabia is seasonal where it occurred on these hosts only from October through March with a peak during January and February. These are the most humid months of the year in both regions and at Dammam a relative humidity of 100% prevails over several days of this period and most of the rain falls during these months in both regions (Table 1). This might explain the seasonality of this species in both areas of distribution, as boophilid ticks are known to require considerable levels of humidity for their activity (Hoogstraal 1956). Hence, it seems that the life cycle of the tick in both areas might have been geared in such a way as to make maximum use of the prevailing high levels of both relative humidity and moisture during these months.

During the rest of the year from March onwards, few late feeding females were the only stages of the tick on its goat hosts. This might indicate that, unlike other tropical ticks which are capable of having several generations per annum (Hoogstraal 1956, Norval and Mason 1981, Mustafa *et al.* 1983, Hussein and Mustafa 1985), *B. kohlsi* could only be capable of having a single or possibly two intergrading generations per annum or three generations every two years. The limiting factor in this case might be the drop in the relative humidity which makes *B. kohlsi* somewhat different from temperature zone ticks whose development is hampered by drop in temperature (Hussein 1973, 1980, and Main *et al.* 1982). However, engorged females could be the only stages of the tick capable of overriding this period of reduced relative humidity, since such stages are the only tick instars whose survival is least affected by low levels of relative humidity (Hussein and Mustafa 1987). Other stages of ticks, especially eggs and unfed larvae and nymphs are sensitive to drop in relative humidity (Heath 1979, 1981, Hussein and Mustafa 1987). Engorged females of *B. kohlsi* possibly seek humid enough

niches within its areas of distribution such as under the soil in areas shaded by bushes, shrubs or other vegetational cover to remain quiescent over most of the low relative humidity duration and then start to lay eggs just before or during October. Engorged females of ixodid ticks are known to remain quiescent for even far much longer periods of time to override unfavourable conditions (Hussein 1973).

Larvae of *B. kohlsi* were not represented in any of the samples collected in the present study, nor in any other collections of the tick (Hoogstraal *et al.* 1981). This might be due to the extremely small size of these instars, that made them indiscernible in such hairy, dark-coloured hosts as goats.

Previous collections of *B. kohlsi* from Saudi Arabia were only few scattered specimens from sheep at Abha (Asir Province) by Banaja and Roshdy (1978) and Banaja *et al.* (1980). However, the value of these records is greatly undermined by the lumping of collections from both imported and local animals. Hoogstraal *et al.* (1981) have also reported 3 ♀ of the tick, one from sheep at Abha, one from a goat at Wadi Maraba (Asir Province) and the other was from sheep at Muna abattoir (Makkah Province) which might have been brought into the abattoir from outside the region for sacrifice slaughter during the Haj season. However, an extensive survey of the tick in Asir Province should be fruitful in determining the spread of the tick in that Province, despite its absence from samples collected at both Abha and Khamis Mushayt in the present study. This is because the tick was found in considerable numbers in samples taken from Al-Sarawat Mountains Range of Makkah Province in the present study as well as from the same Range in Yemen Arab Republic (Pegram *et al.* 1982a). The Al-Sarawat Mountains Range forms the bulk of Asir Province and this Range has been postulated to be the natural habitat of the tick in the Arabian Peninsula (Hoogstraal *et al.* 1981, Pegram *et al.* 1982a,b).

During surveys made in the present nationwide tick programme, a total of 12 specimens of *B. kohlsi* was collected from goats at Dammam, Makkah and Taif (Al-Khalifa *et al.* 1987, and Diab *et al.* 1987). However, through vigilance and from the knowledge of the seasonality of the species learned very early in the present study, the present largest ever collection of the tick was made; all of which were only from goats. None of the sheep examined in the present study, nor during the 5-year tick programme (Al-Khalifa *et al.* 1983, 1986, 1987, Al-Asgah *et al.* 1985, Al-Khalifa and Diab 1986, and Diab *et al.* 1987) were found infested with this tick species. These findings strongly support the host preference of the tick for goats postulated by Hoogstraal *et al.* (1981) and was partly proven by Pegram *et al.* (1982a) who found far more goats than sheep infested by the tick in Yemen Arab Republic. However, the original host for *B. kohlsi* in Arabia might well be the Nubian ibex, *Capra ibex nubiana* (Cuvier), as have been postulated by Hoogstraal *et al.* (1981). The Nubian ibex has also been postulated to be the original host for

two other relict species of ticks, *H. arabica* of south western Arabia and *Hyalomma rhipicephaloides* Neumann of the Red Sea-Dead Sea regions (Hoogstraal *et al.* 1981, Pegram *et al.* 1982b, Diab *et al.* 1985) and when the numbers of this host have dwindled, its tick parasites had to seek other hosts of comparable size, possibly the goat which is very much related to the ibex, both being members of the genus *Capra*. However, single collections of *B. kohlsi* were also made from a donkey as well as from a camel (Hoogstraal *et al.* 1981) and we have 1 ♀ from a cat at Al-Baha, but these might have been just accidental infestations.

The present observations on the coexistence of both *B. kohlsi* and *H. arabica* on the same hosts in the Al-Sarawat Mountains of Makkah Province, might support the postulations that both species were original parasites of the Nubian ibex that have preferred goats as hosts in south western Arabia. Moreover, the present findings on *H. arabica* are in line with the belief that this species does not occur outside the Al-Sarawat Mountains Range of south western Arabia (Pegram *et al.* 1982b, Hoogstraal *et al.* 1983, Diab *et al.* 1985, Al-Khalifa *et al.* 1986). On the other hand, the present distribution of *B. kohlsi* in the Arabian Gulf Coast of the Eastern Province of Saudi Arabia is a new locality record for the tick far from its postulated natural habitat of vegetated hill and valley biotopes of south western Arabia (Hoogstraal *et al.* 1981). However, this new record locality for the tick is a hot and humid lowland similar to its type locality of the Jordan Valley (Hoogstraal and Kaiser 1960, Hadani *et al.* 1964). Within this locality, the tick seems to be confined to the humid coastal areas as it was not found in parts of the Eastern Province of Saudi Arabia away from the Arabian Gulf Coast, like Al-Hafr (Fig. 1). Moreover in this locality, *B. kohlsi* coexists on the same goat hosts mainly with *R. turanicus*. This is understandable as the Eastern Province of Saudi Arabia is known to be one of the main areas of distribution of *R. turanicus* in the Arabian Peninsula and goats are one of its preferred hosts (Diab *et al.* 1987).

In the Arabian Peninsula, *B. kohlsi* is absent from the Sultanate of Oman (Hoogstraal 1981) and from most of the Kingdom of Saudi Arabia (Abou-Elela *et al.* 1981, Hoogstraal *et al.* 1981, Al-Khalifa *et al.* 1983, 1984, 1987, Al-Asgah *et al.* 1985, Al-Khalifa and Diab 1986, and Diab *et al.* 1987). Nevertheless, great vigilance and intensive surveillance should be applied to prevent its spread to other areas of the Kingdom. This is because the small 1-host boophilid ticks are notorious for building up dramatically large populations within short periods of time and that they are extremely difficult to control as they are renowned to develop genetically based resistance to several acaricides (Hoogstraal and Tatchell 1985). This should be done despite the fact that the disease relationships of *B. kohlsi* are yet to be investigated, but other boophilid species are known vectors of very important animal diseases such as babesiosis (Hoogstraal 1956, Hoogstraal *et al.* 1981, Hoogstraal and Tatchell 1985) and studies on the disease relationships of this tick should be rewarding. It might well be the vector of either or both of *Babesia motasi* Wenyon and *Babesia ovis* (Babes) detected in the blood of goats in the Eastern

Province of the Kingdom. (Hussein, Al-Khalifa, Diab and Al-Asgah, unpublished data).

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تحديد مناطق الانتشار والمدى العائلي والتوافر الموسمي لقراد الماعز والأغنام العربي *Boophilus kohlsi* في المملكة العربية السعودية

حسين سر الختم حسين و محمد صالح الخليفة و فتحي مسلم دياب
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المملكة العربية السعودية

تمت هذه الدراسة في أماكن مختارة بإتقان بعيداً عن أي اختلاط بين الحيوانات المستأنسة المحلية والمستوردة بهدف تحديد أماكن الانتشار والمدى العائلي والتوافر الموسمي لقراد الماعز والأغنام العربي الجامد من نوع *Boophilus kohlsi* في مناطق المملكة العربية السعودية جميعها. ولقد أجريت الدراسة بجمع كل القراد الذي يوجد في ١٠ حيوانات على الأقل من كل من الجمال والأبقار والماعز والأغنام وذلك شهرياً خلال عامي ١٩٨٢ / ١٩٨٣ م و ١٩٨٤ / ١٩٨٥ م من المناطق المحدده للدراسة. جمع هذا القراد في أنابيب زجاجية بحجم ٢٥ × ١٠٠ ملمتر محتوية على كمية من الكحول الأيثيلي بتركيز ٧٠٪ وكتب على كل أنبوبة نوع الحيوان الذي جمع منه القراد وتاريخ الجمع والمنطقة التي تم فيها الجمع. ولقد تم كذلك تدوين الخصائص الجغرافية الطبيعية لكل منطقة درست من إرتفاع وتضاريس ونباتات طبيعية، وكذلك سجلت العوامل المناخية لكل منطقة وذلك بعد الحصول على هذه المعلومات من قسم المياه، بوزارة الزراعة والمياه بالرياض.

في المختبر تم تنظيف القراد المجموع من الشوائب العالقة به تنظيفاً جيداً وفحصه تحت مجهر تشريح وبالتالي تعريفه وتصنيفه.

ولقد أوضحت الدراسة أن *Boophilus kohlsi* يتطفل على الماعز فقط في مناطق جبال السروات بمنطقة مكة المكرمة وكذلك في المناطق الساحلية للمنطقة الشرقية في المملكة العربية السعودية. ولقد سبق تسجيل هذا النوع من القراد في جبال

السروات في الجمهورية العربية اليمنية وكذلك تعتبر منطقة جبال السروات في جنوب غربي الجزيرة العربية مناطق طبيعية لوجود هذا النوع في الجزيرة العربية . ولكن هذه هي المرة الأولى التي يسجل فيها هذا النوع من القراد من مناطق ساحل الخليج العربي في المملكة العربية السعودية . ومما تجدر الإشارة إليه أن هذه المناطق مناطق منخفضة وحارة وشديدة الرطوبة مثلها في ذلك مناطق وادي نهر الأردن حيث وصف هذا النوع من القراد لأول مره .

وخلافاً لما سجل خلال دراسة هذا النوع في الجمهورية العربية اليمنية من حيث أن هذا القراد يصيب الماعز والأغنام معا ويتطفل عليها طول السنه ، فإن الدراسة الحالية قد أوضحت أن هذا القراد يصيب الماعز فقط في المملكة العربية السعودية ويوجد عليها في الفترة من شهر أكتوبر إلى شهر مارس فقط . وبالرجوع إلى السجلات المناخية نجد أن هذه الشهور هي شهور السنة الأكثر رطوبة ، كما وأن غالبية المطر يهطل عليها في منطقتي وجود هذا القراد في المملكة العربية السعودية وهذا مما يلائم متطلبات هذا القراد البيئية ، لذلك نجده ينشط خلال هذه الفترة فقط من العام ، أما بقية العام حيث تكون درجة الرطوبة منخفضة بعض الشيء فإنه غالباً ما تمضيها أناث هذا اقراد الممتلئة بالدم مخبئة في حالة سكون في الأماكن الأكثر رطوبة كالجحور وخلافها . وهذه لا تنشط إلا قرب أو عند بداية شهر أكتوبر حيث تبيض ويواصل القراد نشاطه من جديد . وعليه فإن هذا النوع من القراد لا يستطيع أن ينتج أكثر من جيل واحد فقط من الأنجال في العام الواحد . وهذا يخالف قراديات المناطق الحاره ويمائل إلى حد ما قراديات المناطق المعتدلة ولكن العامل المتحكم في ذلك هو درجة الرطوبة وليست درجة الحرارة كما في قراديات المناطق المعتدلة . ولقد نوقشت في البحث احتمالات تأثير درجة الرطوبة على اطوار القراد المختلفة وعلى دورة حياته من ناحية عامة .

كما أن هذا القراد يوجد على نفس العوائل مع أنواع أخرى من القراد في منطقتي انتشاره في المملكة ، فهو يوجد أساساً مع نوع *Rhipicephalus turanicus* على الماعز في المنطقة الشرقية والتي هي من أهم مناطق انتشار نوع *R. turanicus* في

الجزيرة العربية . أما في مناطق جبال السروات في منطقة مكة المكرمة فهو يوجد على الماعز نفسه مع نوع *Hyalomma arabica* . وهذين النوعين وكذلك نوع *Hyalomma rhipicephaloides* تعتبر في الأساس طفيليات للماعز الجبلي ونظراً لإضمحلال أعداد الماعز الجبلي فإنه توجب على هذه الطفيليات البحث عن عوائل أخرى بنفس حجم عائلها الأساسي وعليه إختارت الماعز المستأنس . وبالرغم من محدودية إنتشار هذا النوع في المملكة العربية السعودية إلا أنه يتوجب الحرص الشديد لمنع إنتشاره إلى مناطق أخرى .