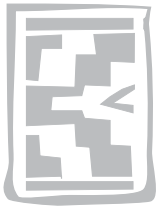

Distribution and population dynamics of ticks (Acari: Ixodidae) infesting sheep in Sennar State, Sudan

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ABSTRACT

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A cross-sectional survey of ticks infesting sheep was conducted in Sennar State, Sudan. A total body collection of ticks was carried out at five localities Sennar town, Singa, Dinder, Abu Naama and Um Banein on two types of Desert sheep (Watish and Ashgar) on two farms at each locality at two monthly intervals for one year starting July 2002 to May 2003. Four tick genera and eight species were identified. They were *Amblyomma lepidum, Hyalomma anatolicum anatolicum, Hyalomma truncatum, Rhipicephalus (Boophilus) decoloratus, Rhipicephalus camicasi, Rhipicephalus evertsi evertsi, Rhipicephalus guilhoni* and *Rhipicephalus muhsamae*. A significant ($P \leq 0.05$) seasonal pattern of activity was observed for *A. lepidum* and *R. guilhoni* with peak activity occurring during rainy seasons. The highest mean number of ticks (7.26 ± 0.58) was recorded at Abu Naama, while the lowest mean (3.61 ± 0.31) was recorded in Sennar. Watish type sheep carried significantly ($P \leq 0.05$) more ticks than Ashgar type.

Keywords: Population dynamics, Sudan, ticks

INTRODUCTION

Ticks and tick-borne diseases (T&TBDs) are major constraints to livestock improvement in many parts of the world especially in the tropics (Walker, Bouattour, Camicas, Estrada-Peña, Horak, Latif, Pegram & Preston 2003). T&TBDs of sheep and goats are less well studied than those of cattle. Nevertheless, small ruminants are able to acquire resistance to most tick species and principles of enzootic stability and the need to preserve it are similar to those in cattle (Tatchell 1997).

The Sudanese tick fauna comprises 68 tick species (Osman 1978; Jongejan, Zivkovic, Pegram, Tatchell, Fison, Latif & Paine 1987), many of which have veterinary importance. Hoogstraal (1956) conducted the first systematic studies on ticks in the Sudan. Osman (1978) confirmed 20 tick species infesting domestic animals in Darfur State, Western Sudan, while Jongejan *et al*. (1987) reported 24 species infesting cattle and wildlife along the Blue Nile and the White Nile rivers.

Recently Salih, Hassan, El Hussein & Jongejan (2004) identified 12 species infesting cattle at different localities in the Northern, Central, Western and Eastern Sudan. The distribution of T&TBDs has changed, due to the extensive animal movement, deforestation, desertification and the establishment of large mechanized agricultural schemes (Hassan & Salih 2005). Studies on the seasonal occurrence of the various developmental stages of ticks are of

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great significance in the epidemiology of tick-borne diseases and in planning appropriate tick control measures (Norval, Andrew & Meltzer 1991). The objectives of this study were to elucidate the distribution and seasonal population changes of ticks infesting sheep in Sennar State, Sudan.

MATERIALS AND METHODS

Study area

The study was conducted at five localities in Sennar State during the period July 2002 to May 2003. These included Sennar town (13°33' N, 33°37' E), Singa (13°09' N, 33°57' E), Dinder (13°44' N, 34°12' E), Um Banein (13°04' N, 33°57' E) and Abu Naama (12°44' N, 34°08' E) (Fig. 1). Meteorological data were recorded throughout the study period.

Tick collection

Total body collections of ticks infesting sheep were carried out on two farms at each locality at two monthly intervals for one year (July 2002 to May 2003). Ten adult sheep of different types were randomly chosen on each farm. These animals were of different coat colour and different sex. Debilitated sheep and pregnant ewes were excluded. All visible ticks were collected from the entire body surface using a pair of blunt metal forceps. The collected ticks were preserved in vials containing 70% ethyl alcohol. Animal type, coat colour, locality, farm and date of collection were recorded. Ticks were identified under a dissecting microscope using the description of Hoogstraal (1956), Walker, Keirans & Horak (2000) and Walker *et al*. (2003). The ticks recovered from each animal were recorded according to genera, species, sex and developmental stages.

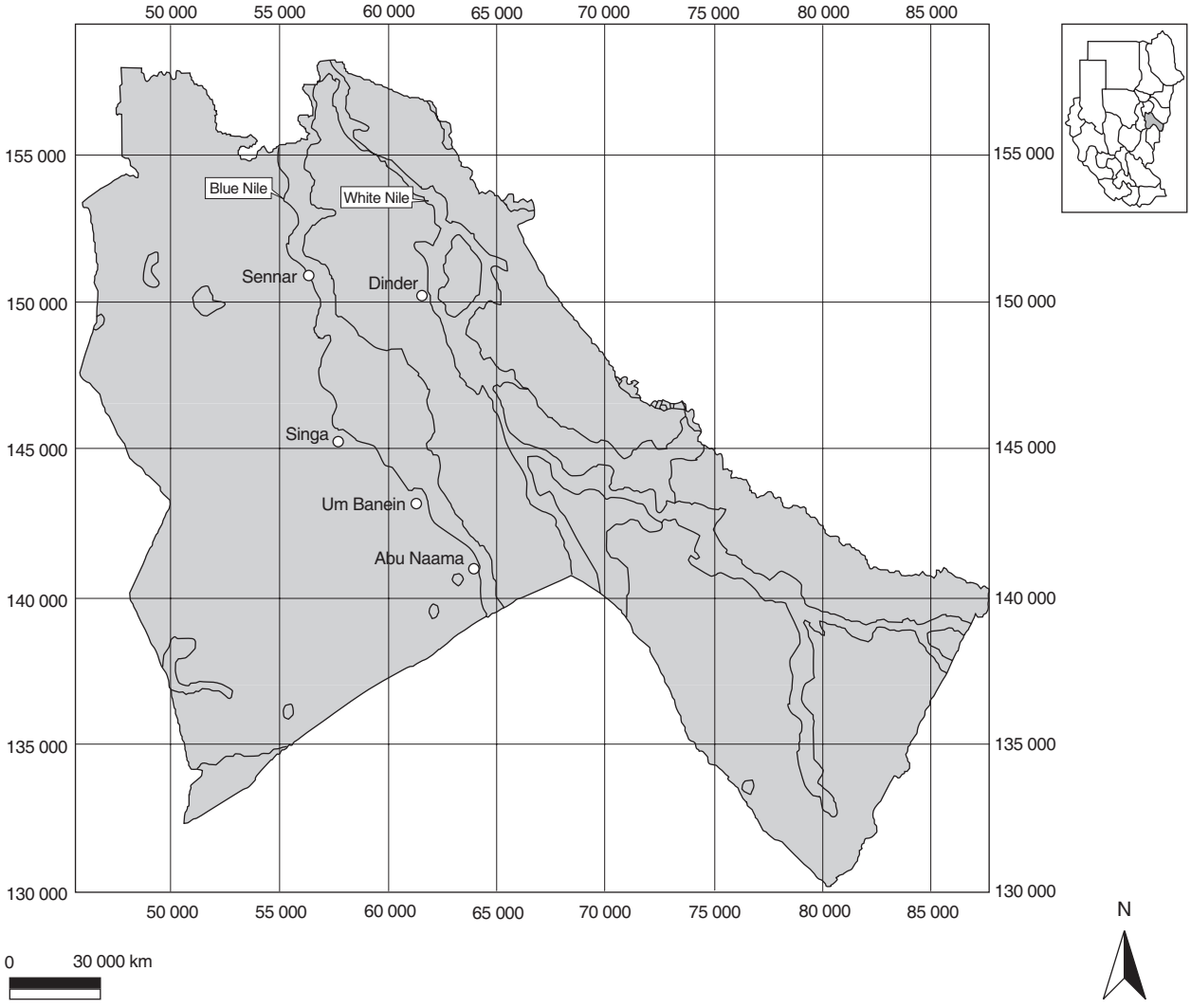

FIG. 1 Map of Sennar State showing localities at which samples were collected

Statistical analysis

Data collected on ticks infesting sheep at different locations were subjected to appropriate general linear model (GLM) procedure of statistical analysis system (SAS) package. The SAS was used to perform analysis of variance (ANOVA) while mean separations were performed using Ryan- Einot- Gabriel-Welsch (REGW) multiple range test (Day & Quinn 1989). Correlation analysis was carried out to relate tick abundance to meteorological data.

RESULTS

Three tick genera and eight species were identified. These were *Amblyomma lepidum, Hyalomma anatolicum anatolicum* and *Hyalomma truncatum, Rhipicephalus (Boophilus) decoloratus, Rhipicephalus camicasi, Rhipicephalus evertsi evertsi, Rhipicephalus guilhoni* and *Rhipicephalus muhsamae*.

The mean total numbers of ticks per sheep at different localities are summarized in Table 1. The highest mean (7.26 $\pm$ 0.58) was recorded at Abu Naama, while the lowest mean (3.61$\pm$ 0.31) was recorded in Sennar town. Seasonal occurrence of adult ticks revealed that the peak (2.75 $\pm$ 0.43) of *A. lepidum* occurred in November and the lowest (0.47 $\pm$ 0.13) record was in January. The peak (1.66 $\pm$ 0.30) of *R. e. evertsi* occurred in March and the lowest (0.18 $\pm$ 0.05) collection was in September. The highest abundance (7.84 $\pm$ 0.57) of *R. guilhoni* was in September while the lowest was in May (Table 2). Table 3 summarizes the mean numbers of adult ticks per head of sheep according to sheep type.

The tick species found in small numbers were *R. (B.) decoloratus, H. a. anatolicum, H. truncatum, R. camicasi,* and *R. muhsamae*. Table 5 shows information on their geographic distribution and total count.

The correlation analysis between the mean total numbers of the three most numerous tick species and mean monthly maximum and minimum ambient temperatures, relative humidities, and total monthly rainfall are shown in Table 4. Data on geographic distribution, seasonal occurrence and correlation with meteorological parameters are given for each tick species separately as indicated below.

Amblyomma lepidum

This tick species was present at all localities. The highest mean (2.37 $\pm$ 0.19) total body collected ticks was recorded at Um Banein and the lowest (0.16 $\pm$ 0.05) in Sennar (Table 1). There was a clear pattern of seasonality of *A. lepidum* being significantly abundant in November and the least abundance was in January and July (Table 2). There was no significant difference ($P \geq 0.05$) between *A. lepidum* infestation and sheep type (Table 3). On the other hand, there was no significant correlation between *A. lepidum* occurrence and mean monthly maximum ambient temperature. Similarly, there was no apparent correlation between the occurrence of this tick and mean monthly minimum atmospheric temperature. Furthermore, there was no well-defined relationship between *A. lepidum* occurrence and total monthly rainfall nor mean monthly relative humidity (Table 4).

Hyalomma a. anatolicum

This xerophilic tick was collected in low numbers during the study period. The highest number was recorded in Sennar, followed by Dinder and only three males and one female were found at Um Banein (Table 5).

Hyalomma truncatum

Only two males were collected at Abu Naama during the dry season (March and May) (Table 5).

Rhipicephalus (B.) decoloratus

This tick was recorded in very low numbers during the rainy season (July and September) at Um Banein, Abu Naama and Singa (Table 5). All the ticks collected were females.

Rhipicephalus e. evertsi

Rhipicephalus e. evertsi was collected at all localities. It was highly abundant in Singa and Sennar while the lowest record was at Um Banein (Table 1). There a clear pattern of seasonality of this tick being abundant in the dry season of March and May and the lowest record was in the wet season of September (Table 2). There was no significant correlation ($P \geq 0.05$) between *R. e. evertsi* abundance and sheep type (Table 3). There was a strong positive correlation between *R. e. evertsi* abundance and mean monthly maximum atmospheric temperature, and mean monthly minimum atmospheric temperature (Table 4). There was also a significant negative correlation between *R. e. evertsi* abundance and mean monthly relative humidities, but the correlation was not significant with total monthly rainfall (Table 4).

Rhipicephalus guilhoni

This species was present at all localities being highly abundant in Dinder and Abu Naama (Table 1).

TABLE 1 Mean (± SE) numbers of ticks collected from sheep at different localities in Sennar State, Sudan during 2002–2003

Localities	*A. lepidum*	*R. e. evertsi*	*R. guilhoni*	Total no. of ticks
Um Banein	2.37 ± (0.19)[a]	0. 27 ± (0.06)[b]	3.51 ± (0.25)[a]	6.14 ± (0.38)[a]
Abu Naama	1.78 ± (0.33)[a]	0.72 ± (0.13)[b]	4.76 ± (0.47)[a]	7.26 ± (0.58)[a]
Dinder	1.03 ± (0.17)[b]	0.58 ± (0.16)[b]	5.43 ± (0.50)[a]	7.05 ± (0.53)[ab]
Singa	0.55 ± (0.11)[bc]	1.43 ± (0.33)[a]	3.71 ± (0.28)[b]	5.68 ± (039)[b]
Sennar	0.16 ± (0.05)[c]	0.84 ± (0.16)[ab]	2.62 ± (0.26)[b]	3.61 ± (0.31)[c]

Number of observations = 120 at each locality

Means (± SE) followed by the same letter in each column are not significantly different at the 5% level based on Ryan's Q test (REGWQ)

TABLE 2 Mean (± SE) numbers of ticks collected from sheep in Sennar State, Sudan in various months during 2002–2003

Month	*A. lepidum*	*R. e. evertsi*	*R. guilhoni*	Total no. of ticks
July 2002	0.90 ±(0.19)[c]	0.87 ± (0.14)[bc]	5.60 ± (0.48)[b]	7.37 ± (0.50)[b]
September 2002	1.53 ± (0.20)[b]	0.18 ± (0.05)[c]	7.84 ± (0.57)[a]	9.55 ± (0.61)[a]
November 2002	2.75 ± (0.43)[a]	0.35 ± (0.10)[c]	3.98 ± (0.49)[c]	7.08 ± (0.49)[b]
January 2003	0.47 ± (0.13)[c]	0.21 ± (0.10)[c]	3.48± (0.23)[c]	4.16 ± (0.29)[c]
March 2003	0.77 ± (0.23)[bc]	1.66 ± (0.30)[a]	1.67 ± (0.17)[d]	4.10 ± (0.40)[c]
May 2003	0.65 ± (0.13)[bc]	1.33 ± (0.34)[ab]	1.46 ± (0.16)[d]	3.44 ± (0.39)[c]

Number of observations = 100 in each month

Means (± SE) followed by the same letter in each column are not significantly different at the 5% level based on Ryan's Q test (REGWQ)

TABLE 3 Mean (± SE) numbers ticks collected from different sheep types

Sheep type	No. of sheep examined	*A. lepidum*	*R. e. evertsi*	*R. guilhoni*	Total no. of ticks
Watish	438	1.08 ± (0.12)[a]	0.83 ± (0.11)[a]	4.40 ± (0.21)[a]	6.32 ± (0.27)[a]
Ashgar	162	1.43 ± (0.22)[a]	0.58 ± (0.12)[a]	2.94 ± (0.21)[b]	4.96 ± (0.32)[b]

Means (± SE) followed by the same letter in each column are not significantly different at the 5% level based on Ryan's Q test (REGWQ)

TABLE 4 Correlation analysis between tick species infesting sheep in Sennar State and meteorological data

Tick species	Temperature		Relative humidity	Total rainfall
	Max	Min		
A. lepidum	–0.02 ns	0.07 ns	0.06 ns	–0.02 ns
R. guilhoni	–0.44 ***	0.05 ns	0.52 ***	0.33 ***
R. e. evertsi	0.20 ***	0.10 ***	–0.13 ***	–0.02 ns
Total ticks	**–0.29 *** **	**0.12 *** **	**0.40 *** **	**0.25 *** **

*** $P < 0.001$

ns not significant

TABLE 5 Total numbers of ticks (male/female) infesting sheep in very low numbers at different localities in Sennar State in 2002/2003

Locality	*B. decoloratus*	*H. a. anatolicum*	*H. truncatum*	*R. camicasi*	*R. muhsamae*
Um Banein	0/3	3/1	0/0	8/2	1/0
Abu Naama	0/3	0/0	2/0	10/3	1/0
Dinder	0/0	19/13	0/0	3/2	2/0
Singa	0/1	0/0	0/0	3/2	5/2
Sennar	0/0	73/30	0/0	3/2	1/0
Total ticks	**0/7**	**95/44**	**2/0**	**27/11**	**10/2**

This tick showed a significant pattern of seasonality with a clear peak in September but drastically decreased in the dry season of March and May (Table 2). Watish type of sheep carried significantly more *R. guilhoni* than Ashgar type (Table 3). There was a strong negative correlation between *R. guilhoni* abundance and mean monthly maximum atmospheric temperature, but there was no significant correlation between the abundance of this tick and mean monthly minimum atmospheric temperature (Table 4). The largest burdens of *R. guilhoni* coincided with the rainfall period and increased relative humidity (Table 4).

Rhipicephalus camicasi

This species was collected in low numbers throughout the study period at all localities. The highest number was reported at Abu Naama during dry seasons (November, January, March and May) (Table 5).

Rhipicephalus muhsamae

This West African tick species was present in very low numbers during the dry seasons (November, January and March) at all localities (Table 5).

DISCUSSION

Since the major study of Hoogstraal (1956) on ticks in the Sudan, and that of Jongejan *et al.* (1987) of the Blue and White Nile ecosystem, no systematic research has been conducted on the distribution and seasonal occurrence of ixodid ticks in Sennar State. The present study yielded eight tick species infesting sheep at five localities (Table 1). This finding is similar to those previously reported in Darfur, Kordofan and along the banks of the White and Blue Nile rivers (Osman 1978; Osman, El Hussein, Neima & Abdulla 1982; Jongejan *et al*. 1987).

Tick numbers on sheep were relatively low. The highest mean total number of ticks was recorded at Abu Naama, while the lowest mean was reported in Sennar. This may be attributed to the effect of occasional chemical acaricide treatments administered during the wet season. There was a clear pattern of seasonality for *A. lepidum* and *R. guilhoni*. Karrar, Kaiser & Hoogstraal (1963) reported similar seasonal effects for *A. lepidum* in Kassala. In Kordofan the number of *A. lepidum* reached a peak between August and September in the rainy season (Osman *et al.* 1982). Jongejan *et al.* (1987) reported no pattern of seasonality for *A. lepidum* or any other tick species in Northern Sudan. They attributed this to the irregular intervals between collections. *Amblyomma lepidum* occurs in a wide variety of climatic zones, from temperate (highland) to savannah, steppe and desert, but it is most common in arid habitats with 250–750 mm rainfall (Walker *et al.* 2003). *Rhipicephalus guilhoni* was the predominant species throughout the study period in all locations. Osman (1978) and Osman *et al.* (1982) during their studies in Darfur and Kordofan provinces found that the predominant ticks belong to the *R. sanguineus* group. *Rhipicephalus guilhoni* can exist under relatively dry conditions in areas with 500–750 mm annual rainfall, and even in some places with only 250–500 mm in the southern parts of the Sahel (Walker *et al*. 2003). Walker *et al*. (2000) reported that *R. guilhoni* was probably the most common and widely distributed tick on livestock in Mali and was regarded as the predominant tick species in the Sahelian area of Senegal.

The present study revealed that peak numbers of *R. e. evertsi* were present during the dry seasons with lesser numbers recorded during the rainy seasons. However, Walker *et al*. (2000) have pointed out that *R. e. evertsi* can also be commonly present in habitats receiving between 1200 mm and 2600 mm of annual rainfall. Theiler (1950, cited in Hoogstraal 1956) suggested that increasing aridity limits the distribution of this species and that critical rainfall level lies between 250 mm and 375 mm annually. In the current study *R. camicasi* was found in low numbers in all locations. It is a tick of north-eastern Africa (Walker *et al*. 2000), and had been reported in the Sudan for the first time by Jongejan *et al*. (1987). In Egypt it occurs in stone and gravel desert regions (Walker *et al*. 2000). In Ethiopia and Somalia it is apparently the most active tick species during the dry season (Pegram, Clifford, Walker & Keirans 1987). Osman (1978) and Osman *et al.* (1982) collected small numbers of this tick species during their studies in Western Sudan. Similar to previous studies carried out in the area *Boophilus decoloratus* was found in very small numbers throughout the study period (Jongejan *et al*. 1987; Salih *et al.* 2004). This species occurs in regions with savanna and temperate climates, typically in grasslands and wooded areas used as cattle pasture. It tends to be absent in the drier regions in countries such as Namibia, South Africa and Botswana (Walker *et al*. 2003). Similar to previous studies *R. muhsamae* was found in small numbers (Jongejan *et al*. 1987; Osman, 1978; Osman *et al.* 1982). With the exception of western Uganda, Rwanda and Burundi this species has been recorded across Africa from Senegal to

Ethiopia (Walker *et al.* 2000). It occurs mainly at altitudes of less than 1 000 m in woodland with a mean annual rainfall of 800 m or less (Walker *et al.* 2003).

Hyalomma a. anatolicum is adapted to areas with Mediterranean and steppe climates in North Africa, and to steppe and desert climates elsewhere in its extensive range in the region. It extends as far south as the northern parts of central Sudan (Walker *et al.* 2003). However, the presence of this tick at Um Banein indicates that the limit of this species distribution has changed and that it has moved southwards to latitude 13° N (FAO 1983; Jongejan *et al.* 1987; Salih *et al.* 2004). *Hyalomma truncatum* was recorded in very low numbers at Abu Naama during the dry season. This species had not been recorded along the Blue Nile (Jongejan *et al.* 1987; Salih *et al.* 2004). However, Salih *et al.* (2004) recorded it in Western Sudan and along the White Nile. This species is adapted to dry habitats and is commonest in desert, steppe and savanna climatic regions. It is common in the Afrotropical zoogeographical region and is generally restricted to areas south of the Sahara (Walker *et al.* 2003)

Watish type sheep were found to be significantly ($P < 0.05$) more heavily infested with ticks than Ashgar type sheep. This finding may be attributed to the coat colour of the animal as Hassan (1997) has found that tick burdens may be correlated with host coat colour. He found that cattle with white coats predominantly carried significantly more ticks than those with brown coats, while black-coated cattle carried the least number of ticks. He suggested that ticks picked up by animals with black or brown coats die or leave the host before attachment, because of the raised temperature of the host environment generated by the dark coat colour.

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