Ticks infesting animals in the Sudan and southern Sudan: Past and current status

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In this review, we collate information about ticks identified in different parts of the Sudan and South Sudan since 1956 in order to identify gaps in tick prevalence and create a map of tick distribution. This will avail basic data for further research on ticks and policies for the control of tick-borne diseases. In this review, we discuss the situation in the Republic of South Sudan as well as Sudan. For this purpose we have divided Sudan into four regions, namely northern Sudan (Northern and River Nile states), central Sudan (Khartoum, Gazera, White Nile, Blue Nile and Sennar states), western Sudan (North and South Kordofan and North, South and West Darfour states) and eastern Sudan (Red Sea, Kassala and Gadarif states).

Introduction

Ticks may have both direct and indirect adverse effects on their host animals. They feed on blood, leading to anaemia, and the injuries caused by their attachment damage hides and predispose animals to secondary bacterial infections that may lead to mastitis. These wounds may also be attractive to the myiasis-causing flies. Ticks can cause paralysis and probably transmit a greater variety of organisms that cause diseases than any other arthropod (Hoogstraal 1956). The economically most important tick-borne diseases are theileriosis, babesiosis, ehrlichiosis (heartwater) and anaplasmosis. The study of ticks that parasitise domestic animals is of considerable importance in that it assists in determining their host preference, their seasonality and geographic distribution, the diseases they may transmit and their control (King, Getting & Newson 1988). On-host ticks may be affected by factors such as species, breed and immune status, whilst free-living ticks are affected by climate, geographic region and seasonality. During the late 1940s and early 1950s Hoogstraal (1954, 1956) collected ticks from more than 50 localities in Southern Sudan and 15 localities in Northern Sudan. He recorded 38 tick species in the southern Sudan provinces, seven in other provinces and 18 that were found in both Southern Sudan and other provinces.

In this review, we collate the findings on ticks identified in various regions of the Sudan and in South Sudan since Hoogstraal's survey (1956). The information should assist in filling some of the gaps in our knowledge about the ticks of the Sudan and South Sudan in order to compile a map illustrating tick distribution in both countries. The data could also provide a basis for further research on ticks and tick-borne diseases, which would be useful for developing control policies.

For the purposes of the review, we have included data from the Republic of South Sudan as well as from the Sudan, divided into northern Sudan (Northern and River Nile states), central Sudan (Khartoum, Gazera, White Nile, Blue Nile and Sennar states), western Sudan (North and South Kordofan and North, South and West Darfour states) and eastern Sudan (Red Sea, Kassala and Gadarif states). The localities are shown in Figure 1.

Northern Sudan

Hoogstraal (1956) identified *Amblyomma exornatum*, *Hyalomma dromedarii*, *Hyalomma excavatum*, *Hyalomma impeltatum*, *Hyalomma impressum*, *Hyalomma marginatum*, *Hyalomma scupense* (= *Hyalomma detritum*), *Hyalomma rufipes*, *Hyalomma truncatum*, *Rhipicephalus evertsi evertsi*, *Rhipicephalus praetextatus* and *Rhipicephalus sanguineus* in the northern provinces. Later, Salih *et al.* (2004) collected *Hyalomma anatolicum* from cattle in Atbara and Eddamer, and *Hy. dromedarii* from all localities sampled, as well as *Rhipicephalus* (*Boophilus*) *decoloratus*, *Hy. impeltatum*, *Hy. truncatum*, *Hy. rufipes*, *R. evertsi evertsi*, *R. praetextatus* and ticks belonging to the *R. sanguineus* group from several localities. Ahmed, ElHussein and ElKhidir (2005) reported that in the River Nile State 74% of the ticks feeding on sheep were *Hy. anatolicum*, 15% *R. praetextatus*, 9% *R. sanguineus* group, 2% *R. evertsi evertsi* and 0.5% *Hy. dromedarii*. In the same area the species composition of ticks feeding on camels was *Hy. dromedarii* (89%), *Hy. impeltatum* (7.7%), *Hy. anatolicum* (3.3%), *Hy. truncatum* (0.29%), *Hy. rufipes* (0.25%), *R. praetextatus* (0.30%) and *R. sanguineus* group (0.09%)

FIGURE 1: States of the Sudan and southern Sudan.

(ElGhali & Hassan 2009). The predominant tick species feeding on horses in Atbara were *Hy. anatolicum* (= *Hyalomma anatolicum anatolicum*) (92%) together with *Hy. dromedarii*, *R. evertsi evertsi* and *R. sanguineus* (Salim 2008).

Central Sudan

Hoogstraal (1956) recorded *A. exornatum*, *Amblyomma lepidum*, *Amblyomma variegatum* and *R.* (*B.*) *decoloratus* across central Sudan, except in Khartoum. *Hy. scupense*, *Hy. dromedarii*, *Hy. excavatum*, *Hy. impeltatum*, *Hy. impressum*, *Hy. marginatum* and *Hy. rufipes* were also recorded in central Sudan, except in the Blue Nile region (Hoogstraal 1956). Other species recorded in all states by Hoogstraal (1956) included *R. evertsi evertsi*, *R. praetextatus* and *R. sanguineus*. Just more than 25 years later the dominant tick species north and south of Wad Medani was *Hy. anatolicum* and a *R.* (*Boophilus*) species, respectively (FAO 1983). Tatchell (1983) stated that *Hy. rufipes*, *R. evertsi evertsi* and *R.* (*B.*) *decoloratus* were ubiquitous in their distribution along the Blue Nile, whilst the distribution of *Hy. anatolicum* was restricted to north of Wad Medani. He further reported that *A. lepidum* was common only south of a line between Wad Medani and Khartoum, whilst *Rhipicephalus* (*Boophilus*) *annulatus* was restricted to the area south of Wad Medani.

Ticks of the Blue Nile and White Nile ecosystems were studied by Jongejan *et al.* (1987), who found 24 tick species infesting livestock and wildlife in these areas. Amongst these tick species *Rhipicephalus* (*Boophilus*) *geigyi*, *Rhipicephalus bergeoni* and *Rhipicephalus camicasi* were recorded for the first

time in the Sudan. They also reported that *R.* (*B.*) *annulatus* had extended its distribution further north into the Blue Nile, Gezira and Khartoum regions. During 1979 to 1982, the immature stages of *A. lepidum*, *Hy. anatolicum* and *R. evertsi evertsi* were found feeding on cattle and sheep and immature *A. variegatum* specimens were collected from cattle (Latif 1985). Latif (1985) also found *Hy. impeltatum* nymphs on camels and sheep and *Hy. dromedarii* nymphs on camels for the first time.

In the Khartoum area, Gad Elrab (1986) reported *Hy. anatolicum* (= *Hy. a. anatolicum*), *Hy. dromedarii*, *Hy. truncatum*, *R. evertsi evertsi*, *R. praetextatus* and ticks of the *R. sanguineus* group on local sheep. Similarly, Osman (1999) collected *Hy. anatolicum*, *R. evertsi evertsi* and ticks of the *R. sanguineus* group from sheep on the Khartoum University Farm, north of Khartoum. Abdoon, Osman and EL Wasila (1992) collected 1344 ticks from horses, amongst which 97.4% were *Hy. anatolicum* and the rest *Hy. dromedarii*, *Hy. rufipes* and *R. evertsi evertsi*. In the southern parts of Khartoum, adjacent to Gazera State, exotic cattle were found to be infested with *Hy. anatolicum*, *Hy. rufipes*, *R.* (*B.*) *decoloratus*, *R. evertsi evertsi* and ticks of the *R. sanguineus* group (Mohamed, Aziz & Kheir 1998). According to Mohammed (2002) *A. lepidum* was the predominant tick species in the Blue Nile State and infestation of host animals occurred throughout the year.

According to Lazarus (2002), who collected ticks from cattle in and around Wad Medani in central Sudan from May to July 2002, *Hy. anatolicum* was the most abundant species, followed by *R. evertsi evertsi*, *Hy. rufipes*, *R. sanguineus*, *A. lepidum* and *R.* (*B.*) *decoloratus*. All his collections of *A. lepidum* were male specimens. ElImam (2003) found that 11 tick species infested cattle in Kosti (central Sudan), amongst which *A. variegatum*, *Hy. anatolicum* and *Hy. excavatum* were reported for the first time in this area. Mohammed, Osman and ELrabaa (2004) recorded *A. lepidum*, *Hy. anatolicum* (70% and 83%, respectively) at Soba and Kuku and *Hy. dromedarii*, *Hy. impeltatum*, *Hy. rufipes*, *R. evertsi evertsi* and ticks of the *R. sanguineus* group on cattle in Khartoum. Salih *et al.* (2004) collected *A. lepidum* from cattle along the Blue Nile, from Wad Medani to Damazin and along the White Nile, from Eduaim to Rabak. They also found *A. variegatum* in Kosti. In addition, they collected *Hy. anatolicum* in Khartoum and in relatively high numbers in Um Benin (Blue Nile, south of Wad Medani), whilst *Hy. dromedarii* was present in all localities sampled except Kosti. Other ticks recorded by Salih *et al.* (2004) in other localities of central Sudan were *R.* (*B.*) *decoloratus*, *Hy. impeltatum*, *Hy. rufipes*, *Hy. truncatum*, *R. evertsi evertsi*, *R. praetextatus* and ticks of the *R. sanguineus* group. Export sheep (Hamari and Watish) brought to the Al Kadaro slaughterhouse (Khartoum State) from the White Nile, Blue Nile, Kordofan and Gadarif states were found to be infested with *A. lepidum*, *Hy. anatolicum*, *Hy. dromedarii*, *Hy. impeltatum*, *Hy. rufipes*, *Hy. truncatum*, *R.* (*B.*) *decoloratus*, *R. camicasi*, *R. evertsi evertsi*, *Rhipicephalus guilhoni* and *Rhipicephalus muhsamae* (Elfaki 2005).

Mohammed and Hassan (2007) studied the ticks that infested sheep in Sennar State and recorded *A. lepidum*, *Hy. anatolicum* (= *Hy. a. anatolicum*), *Hy. truncatum*, *R.* (*B.*) *decoloratus*, *R. camicasi*, *R. evertsi evertsi*, *R. guilhoni* and *R. muhsamae.* Salim (2008) found that the dominant tick species infesting horses in Kosti was *Hy. anatolicum* (= *Hy. a. anatolicum*) (92%), whilst *Hy. dromedarii*, *R. evertsi evertsi* and *R. sanguineus* were also present. In the Butana area, Eltigani (2009) recorded *A. lepidum*, *A. variegatum*, *Hy. anatolicum*, *Hy. dromedarii*, *Hy. impeltatum*, *Hy. rufipes*, *Hy. truncatum*, *R.* (*B.*) *decoloratus*, *R. evertsi evertsi* and *R. sanguineus* on camels.

Western Sudan

Hoogstraal (1956) recorded *A. exornatum*, *A. lepidum*, *A. variegatum* and *R.* (*B.*) *decoloratus* in western Sudan and *R.* (*B.*) *annulatus* in Kordofan. He also reported the presence of *Hy. dromedarii*, *Hy. excavatum*, *Hy. impeltatum*, *Hy. impressum*, *Hy. marginatum*, *Hy. rufipes*, *Hy. scupense*, *R evertsi evertsi*, *R. praetextatus* and *R. sanguineus*. Although Osman *et al.* (1982) later recorded various species of *Amblyomma*, *Rhipicephalus* (*Boophilus*) and *Hyalomma* in Kordofan, the dominant tick species was *Hy. impeltatum*. Osman (1997) also argued that the unusual distribution of *A. lepidum* and *A. variegatum* on sheep and goats in the Nuba Mountains required further study. In a subsequent study, cattle in Kadogli and Dilling in Kordofan State were found to be infested with *A. lepidum*, *A. variegatum*, *Hy. rufipes*, *Hy. truncatum*, *R.* (*B.*) *annulatus*, *R.* (*B.*) *decoloratus*, *R. evertsi evertsi*, *R. praetextatus* and ticks of the *R. sanguineus* group (Sowar 2002). In ElObeid, the predominant tick species on horses were *Hy. anatolicum* (92%), whilst *Hy. dromedarii*, *R. evertsi evertsi* and *R. sanguineus* were also present (Salim 2008). Salih *et al.* (2004) recorded *A. lepidum* on cattle at several localities in western Sudan, whilst *A. variegatum* was found in ElObeid and Nyala, and *Hy. dromedarii* in all localities sampled.

In Darfour, Osman (1978a) found that *Hy. rufipes*, *Hy. truncatum* and *R. sanguineus* were the dominant species. He also recorded *Hyalomma turanicum*, *R.* (*B.*) *annulatus*, *Rhipicephalus cuspidatus* and *Rhipicephalus sulcatus* for the first time in Darfour and *R. guilhoni* and *Rhipicephalus turanicus* for the first time in the Sudan. Osman (1978b) recorded *A. variegatum*, *Hy. dromedarii*, *Hy. rufipes*, *Hy. truncatum*, *R.* (*B.*) *decoloratus*, *R. evertsi evertsi*, *R. praetextatus*, *R. sulcatus* and *R. turanicus* on sheep at Jebel Marra (Marra Mountain). Ticks belonging to the genera *Amblyomma*, *Rhipicephalus* (*Boophilus*), *Hyalomma* and *Rhipicephalus* were reported from cattle, camels and horses in and around Nyala town, with *Hy. anatolicum* present on dairy farms in Nyala (Gaafar 2008). Adam (2005) reported a single male *Hy. anatolicum* in Buram. Abdalla (2007) recorded 15 tick species belonging to four genera in South Darfour. These included *A. lepidum*, *A. variegatum*, *Hy. anatolicum* (only in Nyala town), *Hy. dromedarii*, *Hy. impeltatum*, *Hy. impressum*, *Hy. rufipes*, *Hy. truncatum*, *R.* (*B.*) *annulatus*, *R.* (*B.*) *decoloratus*, *R. evertsi evertsi*, *R. guilhoni*, *R. muhsamae*, *R. praetextatus* and *R. sanguineus*. With the exception of *R. guilhoni*, *R. muhsamae* and *R. praetextatus*, the same tick species as well as *Hy. excavatum* were found

on dairy cattle in Nyala (Gaafar 2008). According to Ibrahim (2009), the dominant tick species infesting cattle and sheep in North Darfour was *Hy. impeltatum*, whilst *A. lepidum*, *A. variegatum* (accidental introduction possibly by migrating birds), *Hy. dromedarii*, *Hy. rufipes*, *Hy. truncatum*, *R.* (*B.*) *decoloratus* and *R. evertsi evertsi* were also present.

Eastern Sudan

In eastern Sudan, Hoogstraal (1956) recorded *A. exornatum*, *A. lepidum*, *Hy. dromedarii*, *Hy. excavatum*, *Hy. impeltatum*, *Hy. impressum*, *Hy. marginatum*, *Hy. rufipes*, *Hy. scupense* and *R.* (*B.*) *decoloratus*. He also reported *Hy. truncatum* in Kassala and *R. evertsi evertsi*, *R. praetextatus* and *R. sanguineus* in all provinces. Subsequently Karrar, Kaiser and Hoogstraal (1963) stated that *A. lepidum* numbers were high (15.5 ticks per host) in wooded savannah areas (River Atbara), the cultivated Gash Delta and in the *Acacia seyal* savannah of River Gash in Kassala. They also reported *R. sanguineus* on sheep, goats, cattle, camels and donkeys and that *Hy. dromedarii* was the most abundant tick species on camels. The latter species presented together with *A. lepidum*, *Hy. excavatum*, *Hy. impeltatum*, *Hy. rufipes*, *Hy. truncatum*, *R. praetextatus* and *R. sanguineus.* In the same area, Mohamed and Yagoub (1990) identified *R. evertsi evertsi* and *R. sanguineus* on cattle, sheep and equines (horses and donkeys), *Hy. excavatum* and *Hy. rufipes* on cattle and equines, whilst *Hy. dromedarii*, *Hy. marginatum* and *R.* (*B.*) *annulatus* were collected only from cattle. Also in Kassala, Imam (1995) collected 4844 ticks from sheep, including the species *A. lepidum*, *Hy. anatolicum*, *Hy. impeltatum*, *R.* (*B.*) *decoloratus*, *R. evertsi evertsi* and ticks of the *R. sanguineus* group. Salih *et al.* (2004) collected *A. lepidum* from cattle in Gadarif and Port-Sudan, whilst a single *Hy. anatolicum* was collected from one animal in Port-Sudan and *Hy. dromedarii* from all localities except Kassala. In Gadarif, the predominant species on horses was *Hy. anatolicum* (92%), with *Hy. dromedarii*, *R. evertsi evertsi* and *R. sanguineus* also being present (Salim 2008). ElGhali and Babikir (unpublished data) identified 291 ticks collected from 66 cattle in Elgalabat (near the Ethiopian boarder) during 2008, of which 60.6% were *A. lepidum*, followed by *A. variegatum*, *Hy. anatolicum*, *Hy. rufipes*, *Hy. truncatum*, *R.* (*B.*) *decoloratus*, *R. evertsi evertsi*, *R. sanguineus* and *R. turanicus.* In the Red Sea State, the predominant cattle ticks have been found to be *Hy. anatolicum*, *Hy. dromedarii* and *Hy. impeltatum* (Khalid 2009). *Hy. anatolicum* was also abundant in the Toker arera. Other species, including *R. camicasi*, *R.* (*B.*) *decoloratus*, *R. evertsi evertsi* and *R. guilhoni* have been collected in lesser numbers (Khalid 2009).

Republic of South Sudan

Hoogstraal (1956) recorded *Amblyomma cohaerens*, *A. exornatum*, *Amblyomma latum*, *A. lepidum*, *Amblyomma marmoreum*, *Amblyomma nuttalli*, *Amblyomma pomposum*, *Amblyomma rhinocerotis*, *A. variegatum* and *Amblyomma tholloni* in southern Sudan, together with *R.* (*B.*) *annulatus* and *R.* (*B.*) *decoloratus*. He recorded *Dermacentor circumguttatus* and *Dermacentor rhinocerinus* in Equatoria Province and *Haemaphysalis aciculifer*, *Haemaphysalis bequaerti*, *Haemaphysalis hoodi*, *Haemaphysalis houyi*, *Haemaphysalis leachii muhsami* (= *Haemaphysalis muhsamae*), *Haemaphysalis parmata* and *Hy. rufipes* in all southern states. He also recorded *Ixodes cavipalpus*, *Ixodes nairobiensis Ixodes rasus*, *Ixodes schillingsi*, *Ixodes simplex* and *Ixodes vespertilionis* in Equatoria and Bahr El Ghazal Provinces. Furthermore, he recorded *Margaropus reidi* in Bahr El Ghazal Province and *Rhipicephalus appendiculatus*, *Rhipicephalus arnoldi*, *Rhipicephalus bequaerti*, *Rhipicephalus compositus*, *R. cuspidatus*, *Rhipicephalus distinctus*, *R. evertsi evertsi*, *Rhipicephalus kochi*, *Rhipicephalus longicoxatus*, *Rhipicephalus longus*, *Rhipicephalus muehlensi*, *R. praetextatus*, *Rhipicephalus pravus*, *R. sanguineus*, *Rhipicephalus simpsoni*, *R. sulcatus*, *Rhipicephalus supertritus* and *Rhipicephalus tricuspis* in the three provinces of South Sudan.

Rhipicephalus appendiculatus was first reported at Kajo Kaji and Yei in 1950 (Hoogstraal 1956). Later it was also reported in Chukudum, River, Nimuli, Yambio, Nagichot and Juba (Julla 2003). Morzaria *et al.* (1981) reported *A. lepidum*, *A. variegatum*, *Hy. rufipes*, *R. appendiculatus*, *R.* (*B.*) *decoloratus*, *R. evertsi evertsi*, *R. praetextatus* and *R. pravus* on cattle in the south. The dominant tick species in this region is *A. variegatum* (FAO 1983). Jongejan *et al.* (1987) reported that *A. lepidum* and *A. variegatum* had extended their distributions between latitude 5° N and 12° N, whilst when compared to *R.* (*B.*) *decoloratus*, *R.* (*B.*) *annulatus* occupied the forest and wetter areas. Jongejan *et al.* (1987) also recorded *R.* (*B.*) *geigyi* from a single locality in South Sudan. By 1997, *Rhipicephalus* (*Boophilus*) *microplus* had not yet been recorded in the Sudan (Latif & Hassan 1997). In the Pibor area in Jonglei State, Korok (2005) found that *A. lepidum* represented 56.6% of the tick population, *R. sanguineus* 20.5% and *R. evertsi evertsi* 16.2%. Other tick species he recorded were *A. variegatum*, *Hy. rufipes*, *R.* (*B.*) *annulatus*, *R.* (*B.*) *decoloratus* and *R. praetextatus.* Marcellino (2008) recorded *A. variegatum*, *Hy. rufipes*, *R. appendiculatus*, *R.* (*B.*) *decoloratus*, *R. evertsi evertsi*, *R. praetextatus* and ticks of the *R. sanguineus* group on cattle in central Equatoria. He reported that *A. variegatum* was found in all the sampling localities. *R. appendiculatus* was abundant in the Juba area, whilst only a single male *R. appendiculatus* was identified in Mangalla and none in Terekeka.

Discussion

In the Sudan and South Sudan there are different geographic and climatic situations, ranging from the desert zone in the north (with an annual rainfall of less than 100 mm) to wooded savannahs in the south (with annual rainfall of more than 1000 mm). This extraordinary climatic and ecological diversity, coupled with a wide range of domestic and wildlife hosts, serve to accommodate the biological requirements of a variety of tick species. Hassan and Salih (unpublished data) report that factors such as animal movement, habitat change, drought, desertification and global climatic changes may force ticks to extend their distribution ranges beyond their known geographic regions. They report that *A. variegatum* has extended its range north of 12° N, whilst *Hy. anatolicum*

has moved south of 14° N and *R.* (*B.*) *annulatus* was found in the semiarid zone. Abdalla and Hassan (2010) have recently reported on the distribution of *A. variegatum*, *Hy. anatolicum* and *R.* (*Boophilus*) species in various localities of Darfour State.

The distribution of some tick-borne diseases has been altered to some extent because of certain changes in the environment, the movement of animals to new pastures and the spread of certain tick species to new ecological zones. Heartwater, for instance, was originally restricted to the eastern parts of the country where a recognised vector, *A. lepidum*, was abundant (Abdel Rahim & Shommein 1984; Karrar *et al*. 1963). According to Osman and Hassan (2003), *A. lepidum* is restricted to the eastern region, from Torit to Kapoeta in the south to Kassala in the north. Abdalla (2007) reported the presence of antibodies to *Ehrlichia ruminantium* (Heartwater causative agent) in Umdafug and in Reheid-arbirdi in southern Darfour State, and concluded that these results were due to changes in the geographic distribution of ticks and hence the disease. Furthermore, heartwater has recently become endemic in Kordofan and Darfour (Mohammed, unpublished data).

Tropical theileriosis (*Theileria annulata* infections) has been detected in new regions, to where the tick vector *Hy. anatolicum* has extended its distribution range (Abdalla 2007; Gaafar 2008). Salih *et al.* (2004) collected *Hy. anatolicum* from cattle at Umbenein, in the southern regions of the Blue Nile State, proving that the species has extended its distribution southwards, which may lead to the emergence of tropical theileriosis in these areas. Adam (2005) detected *T. annulata* antibodies around Nyala and in Elradom, southern Darfour. In the same state, Abdalla (2007) reported *T. annulata* antibodies in cattle in Eid-elfirsan and concluded that this finding is linked to geographic changes in the distribution of the vector tick. The recovery of *Hy. anatolicum* in several localities in Darfour State (Abdalla & Hassan 2010) confirm the observation.

Similarly, East Coast fever (*Theileria parva* infection) coincides with the distribution of *R. appendiculatus* in the southern part of South Sudan. The first outbreak of East Coast fever was reported in 1950 in the Kajo Kaji and Yei districts on the western bank of the Nile and extended up to Juba (Julla 1985, 1994). The disease was found to be more prevalent in areas that were used for grazing during the dry season, namely Apuk toich, River Lol and the Aweil district (Zessin & Baumann 1982). In the south, scattered tick collections proved that *R. appendiculatus* has moved northwards up to Bore (Julla 2003) and may lead to the occurrence East Coast fever in the southern regions of the north.

Conclusion

In conclusion, numerous tick species are distributed throughout the Sudan and South Sudan and these include the economically most important vectors of disease. Several of the vector tick species have expanded their distribution beyond their previously recognised geographical zones, which may lead to the expansion of tick-borne diseases to new areas where outbreaks of disease are expected to be drastic. Furthermore, ticks and tick-borne diseases in the Sudan represent one of the most important obstacles to livestock production. Hence it seems that without control of ticks and tick-borne diseases, it would be almost impossible to increase livestock production with foreign-breed animals, selection from indigenous breeds or through cross-breeding (Osman 1976).

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Authors' contributions

A.E. (Veterinary Research Institute) suggested the concept of the review, collected most of the used articles and other references, designed the review, wrote the first draft of the review and submitted the review. S.M. H. (University of Khartoum) added some references, improved the written paper and revised all information, particularly the recent tick names.

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