The Journal of Basic and Applied Zoology

REVIEW

Open Access

Current distribution and disease association of Ixodidae (hard ticks) in Nigeria

Stephen Kyari[1*], Matthew Ogwiji[1], Olanrewaju Eyitayo Igah[1], Ochuko Orakpogheno[2] and Khadijat Abidemi Gasaliyu[1]

Abstract

Background: This review documents the hard tick species that have been reported in Nigeria, their distribution, pathogens transmitted and disease they cause in Nigeria; the literature review considered studies that were conducted between 2000 and 2021.

Main body: The hard tick (Ixodidae) species widely present in the country are those of the genera; *Amblyomma, Rhipicephalus/Boophilus, Hyalomma, Ixodes, Dermacentor* and *Haemaphysalis* among which, *Amblyomma* sp, *Hyalomma* sp and *Rhipicephalus* sp. were most widely reported. Ticks cause serious economic losses to the livestock industry via their negative impact on animal health in general and possible transmission of zoonotic pathogens by some species. Ticks' distribution is favoured by factors which include uncontrolled cross-border movement of animals, lack of strict quarantine measures, extensive animal grazing and suitable climatic condition. Tick-borne diseases commonly reported included *Babesiosis, Anaplasmosis, Theileriosis* and *Ehrlichiosis*, while diseases such as Crimean-Congo Haemorrhagic Fever and Africa tick bite fever are under-reported. Also, there is paucity of information on the economic impact of these diseases. Measures that have been implemented in the control of ticks included the use of acaricides and to some extent vaccines.

Conclusions: Ticks and tick-borne diseases constitute serious economic important and studies to fully ascertain these at the national level is recommended. Also, there is need for identification of other species of ticks and under-reported tick-borne diseases to develop more integrated control measures.

Keywords: Ixodidae, Hard ticks, Infection, Nigeria

Background

Ticks are small arachnids belonging to the order Acarina, Suborder Ixodidae, family Ixodidae and Argasidae (Birara, 2017). In Africa, there was remarkable diversity in the tick fauna, with about 50 endemic tick species known to infest domestic animals, and the highest impact on livestock health caused by species belonging to only three genera, namely, *Amblyomma*, *Hyalomma*, and *Rhipicephalus* (Anna et al., 2012). Several studies in Nigeria have documented different species of ticks that infest cattle; however, with regard to the diseases, they cause more research to be focused. Also, the free cross-border movement of animals, especially cattle in West Africa with Nigeria as a case study, due to the ECOWAS protocol, leads to emergence of tick-borne diseases such as Crimea Congo Haemorrhagic fever, rift valley fever and ehrlichiosis among others which are under-reported. The aim of this review was to take a look at ticks' species in different geographical regions of Nigeria and the disease they transmit.

Ticks survived by feeding on the blood of mammals, birds, and sometimes reptiles and amphibians

*Correspondence: kyaristephen757@gmail.com

[1] Department of Veterinary Parasitology and Entomology, Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria, Nigeria
Full list of author information is available at the end of the article

(haematophagy) and were vectors of a number of diseases that affect both humans and other animals (Biu et al., 2012; Cumming, 1998). These parasites constituted a major constrain to livestock production in Nigeria as they could cause considerable economic losses by affecting animal health and productivity (Anna et al., 2012; Fabiyi, 2007). The pathogenic effects of tick infestation were associated with their feeding pattern which is adapted for both penetrating the skin and transmitting microorganisms (Lysyk, 2013). The severe irritations caused by their bites, especially when numerous, could result in emaciation (deficiency in nutrients), anaemia, serious damage to hides and skin (skin lesions, impairment of animal growth) which are valuable export products in Nigeria (Fabiyi, 2007). Ticks were one of the major vectors transmitting pathogens responsible for babesiosis, theileriosis, anaplasmosis dermatophilosis, etc., to animals globally (Morel, 1989; Soulsby, 1982). Tick-borne diseases are of great economic importance due to losses they cause to the cattle industry globally. In Nigeria, the cattle industry contributes significantly to the economic wellbeing of the nomadic herd men as they rely on the income to sustain their families and the nation at large. The ECOWAS protocol allows for the free movement of people, goods and services across the West Africa region, and the porous nature of the borders allows this movement to go uncheck which pose risks in the spread of diseases. Nigeria shares border with Niger, Chad and Cameroon to North, and there is huge economic activity, especially as it relates to livestock with cattle dominating the markets. This forms the rationale behind this study in order to know the current state of tick-borne disease that has been reported and to see whether there is emerging treatment.

Main text

Tick-Borne Diseases

Tick-borne diseases are some of the major constraints to livestock health and production throughout Sub-Saharan Africa and in some cases affect humans (Jesca et al., 2014). The fact that ticks harbouring several pathogens, domestic and wild animals can become infected with these pathogens (Atsuwe et al., 2019). The disease transmitted by ticks are responsible for severe losses caused either by tick worry, blood loss, blood-related infections, damage to hides and udders and the transmission of toxins (Atsuwe et al., 2019; Pam et al., 2019). The major tick-borne diseases that have been reported in Nigeria include Crimean-Congo Hemorrhagic, *Babesiosis, Theileriosis, Anaplasmosis, ehrlichiosis* (Babagana, 2019; Daniel et al., 2020; Hector et al., 2019).

Distribution of ixodid ticks in Nigeria

Ixodid ticks are widely distributed in Nigeria as shown by various studies across the country.

Northern Nigeria

In Bauchi State, the ticks species identified in cattle were *Amblyomma variegatum*, *Amblyomma splendidum*, *Boophilus annulatus*, *Boophilus decolaratus*, *Boophilus geigyi*, *Hyalomma rufipes*, *Hyalomma trancatum* and *Rhipicephalus senegalensis*; in sheep, the species of ticks were *Amblyomma variegatum*, *Boophilus decolaratus*, *Boophilus microples*, *Rhipicephalus sanguinensis* and *Rhipicephalus senegalensis*; in goats *Amblyomma variegatum*, *Hyalomma variegatum*, *Hyalomma trancatum* and *Rhipicephalus sanguinensis* (Aminu, 2015). In Niger State, the tick species identified in cattle were *Amblyomma variegatum*, *Boophilus decoloratus* and *Hyalomma marginatum* (Ejima et al., 2014). *Amblyomma variegatum, Amblyomma lepidum, Hyalomma truncatum, Hyalomma rufipes, Boophilus decolaratus, Boophilus annulatus and Rhipicephalus evertsi* were the species of ixodid ticks identified in cattle in Adamawa State (Pukuma et al., 2011).

In Plateau State, the 3 ticks genera (i.e., *Amblyomma*, *Hyalomma*, and *Rhipicephalus*, including the *Boophilus* sub-genus) and 11 species (*Rhipicephalus (Boophilus) decoloratus, Rhipicephalus (Boophilus) annulatus, Rhipicephalus guilhoni, Rhipicephalus (Boophilus) geigyi, Hyalomma truncatum, Amblyomma variegatum, Rhipicephalus simus, Rhipicephalus turanicus, Rhipicephalus sanguineus, Hyalomma rufipes, Rhipicephalus lunulatus*) were identified (Lorusso et al., 2013). This study ascertained the presence of a broad variety of cattle tick species, most of which are of veterinary importance and the presence of each tick species was correlated with the potential occurrence of tick-borne pathogens and suggestions for tick control in the area were considered. In a study by Adang et al. (2015), the tick species of sheep and goats identified in Gombe State were *Rhipicephalus* species, *Amblyomma* species, *Boophilus* species, *Ixodes ricinus* and *Hyalomma* species. This study concluded that ectoparasites were common to both sheep and goats in Gombe State and thus could affect their health, productivity and economic value.

Opara and Ezeh (2011) identified *Amblyomma variegatum*, *Hyalomma spp*, *Boophilus spp* (*B. microplus*) and *Dermacentor spp. (D. variabilis)* as the ticks infesting cattle in Borno and Yobe States. Also, *Amblyomma variegatum*, *Boophilus decoloratus*, *Hyalomma* spp. and *B. microplus* were the tick species identified in cattle in Benue State (Obadiah et al., 2017). In Sokoto State, the ticks identified in cattle were *Rhipicephalus sanguineous*, *R. evertsi evertsi*, *Amblyomma variegatum*, *Boophilus annulatus*, *Boophilus geigyi*, *Hyalomma impressum*, *Hyalomma rufipes*, *Hyalomma impeltatum*, *Hyalomma dromedarii*, *Boophilus decoloratus* and *Hyalomma truncatum* (Okwuonu et al., 2017).

Southern Nigeria

In Oyo State, the ticks identified were *Rhipicephalus evertsi evertsi, Boophilus decoloratus, Boophilus annulatus, Amblyomma variegatum, Rhiciphalus appendiculatus* and *Haemophysalis leachi* (Ameen et al., 2014; Anna et al., 2012). This parasitological investigation enabled the farmers and veterinarians to have effective prophylactic, therapeutic and control measure of ticks in the study area. Ikpeze et al. (2011) identified *Amblyomma* species, *Boophilus* species, *Hyalomma* species and *Rhipicephalus* species as the ticks of cattle in Anambra State. Joseph et al. (2014) reported *Rhipicephalus* (*Boophilus*) *microplus*, *Amblyomma variegatum*, *Rhipicephalus* (*Boophilus*) *annulatus* and *Amblyomma maculatum* as the ticks of cattle in Enugu State. *Rhipicephalus sanguineus*, *Haemaphysalis laechi* and *Boophylus decoloratus* were identified as ticks of dogs in Cross River State (Arong et al., 2013). Agboola et al. (2022) in a study found tick specie such as Aponomma sp. to infest pangolins in Ogun State (Table 1).

Ixodid ticks in Nigeria and disease relation

Babesiosis

Babesiosis is caused by microscopic parasites (intra erythrocytic protozoan parasites) that infect red blood cells, and different species of *Babesia* parasites were found in animals (domestic and wild) and a few in humans (Gad, 2019; Leeflang & Ilemobade, 1977). The disease is also referred to as piroplasmosis, cattle tick fever, or red water fever. Ticks such as *Boophilus decoloratus, B. annulatus* and *B. geigyi* were reported to transmit the parasite (Leeflang & Ilemobade, 1977). Although the major economic impact of babesiosis is on the cattle industry, infections in other domestic animals, including horses, sheep, goats, pigs, and dogs, assume varying degrees of importance throughout the world. Two important species in cattle *B. bovis* and *B. bigemina* are widespread in tropical and subtropical areas (Jemal, 2017). In a study conducted by Pukuma et al. (2011) on tick-borne infections of cattle, 3 species of tick-borne parasites encountered were *Babesia bigemina, Theileria parva and Anaplasma marginale.* Onoja et al. (2013) in a study reported cattle to be infected with *Babesia bigemina*. In a study to determine the prevalence of babesiosis in stable horses in Ibadan, Oyo State, Nigeria, 14.0% of local breed were positive for *Babesia* parasite at pre-polo competition phase, while 22.0% tested positive at the post-polo competition phase (Oladipo et al., 2015). This could have resulted from invasion of the polo club by ticks from the horses brought in for the competition. In sheep and goats, *Babesia ovis* was reported (Adamu & Balarabe, 2012).

Nonyelu (2013) reported *Babesia* species in dogs attending ECWA Veterinary Clinic, Bukuru, Jos, South Local Government Area, Plateau State. In Makurdi, Benue State, dogs were infected with *Babesia canis* and the ticks identified were *Rhipicephalus, Boophilus and Amblyomma* species (Omudu et al., 2007). Cletus (2019) in parasitological examination of 200 blood samples revealed that 23 were positive for *Babesia canis*; likewise, the dogs were infested with *Rhipicephalus sanguineus*. Konto et al. (2014) in a study found that 48 dogs were infected with *Babesia canis* out of a total of 400 and ticks such *Boophilus spp*, *Rhipicephalus sanguineus*, *Hyalomma spp.* and *Amblyomma variegatum* out of a total of 4216 tick species collected during the study. Isaac et al. (2020) in a study, found out that in blood samples of sheep and goat, *Babesia* spp. were reported to be present. A study carried out by Foluke et al. (2017) revealed that *Babesia spp* were present in 52 of the 109 blood samples of dogs. Obed and Imafidor (2018) reported that cattle examined were infected with *Anaplasma* spp., *Theileria* spp. and *Babesia* spp. from three

Table 1: Shows the distribution of tick species in Nigeria

	Region	
Tick species (genera/subgenera)	Northern Nigeria	Southern Nigeria
Amblyomma	*A. variegatum, A. slpendidum, A. lepidum*	*A. maculatum*
Hyalomma	*H. rufipes, H. truncatum, H. variegatum, H. impressum, H. impeltatum,*	
Rhipicephalus	*R. senegalensis, R. sanguinensis, R. evertsi, R. lunulatus*	*R. evertsi, R. appendiculatus, R. microplus, R. sanguineus*
Boophilus	*B. decoloratus, B. microplus, B. annulatus, B. geygyi*	*B. decoloratus, B. annulatus*
Ixodes	*I. Ricinus*	
Haemophysalis		*H. leachi*

different locations where the cattle were sampled. Garba et al. (2011) revealed that *Babesia* spp. accounted for an overall infection from 5 different locations out of horse samples examined, while *Babesia caballi* accounted for a single infection out of horses examined. In a study by Eyo et al. (2014), it was reported that *Babesia trautmanni* and *Babesia perroncitoi* were present in pigs examined. Anyanwu et al. (2016) revealed *Babesia spp.* were detected in examined sheep and goats. Mathew et al. (2014) in a study on ticks transmitted pathogens in dogs revealed that *Babesia rossi, Theileria* spp., *Anaplasma* spp., *Theiria equi* and *Babesia vogeli* were seen. Atsuwe et al. (2018) found out that in cattle and goat samples examined, haemoparasites identified were *Anaplasma centrale*, *A. marginale, Bebesia bovis* and *Theileria ovis* also occurring in goats. Qadeer et al. (2015) revealed that blood samples collected and examined were positive for *Babesia bigemina*. Nwoha et al., (2013a, 2013b) in a study on incidence of haemoparasites in dogs reported that dogs sampled were positive for *Babesia spp.* Jegede et al. (2014) reported *Babesia canis* to be present in dogs sampled in Abuja. Vincenzo et al. (2016) reported *Babesia bovis* to be present in cattle. Adejinmi et al. (2004) in a study reported that sheep sampled were positive for *Babesia* spp. Mizuki et al. (2007), in a study, reported that dogs were positive for *B. canis rossi* and *B. canis vogeli*. Adamu and Balarabe, (2012) in a study revealed that blood samples of dogs collected were positive for *Babesia canis* infection. Adua and Idahor (2017) revealed blood samples of cattle were positive for *Babesia bovis*. Turaki et al. (2014) revealed that blood samples were positive for *Babesia cabali*. Philip et al. (2020) in a study revealed *Babesia cabali* to be present. Mohammed and Idoko (2012) in a study on haemoparasites and haematological evaluations in Sokoto red goats revealed that *Babesia ovis* was positive in blood samples tested. Adejinmi et al. (2004), in a study revealed that out of blood samples tested, *Babesia* spp. were present. Blood samples collected from dogs in the Federal Capital Territory, Abuja, by Sylvester et al. (2020) revealed *Babesia canis* infection. Wada et al. (2020) reported Babesia species in cattle slaughtered at Zango abattoir. Blood samples collected from horses in Osun State by Shola et al. (2018) revealed that tick infestations were positive for *Babesia species*. Murtala et al. (2020) reported that a nine-year-old girl showed characteristic tetrads (maltese-cross formation) pathognomonic of babesia infection. Mizuki et al. (2007) reported in a molecular study on *Babesia canis* in dogs in Nigeria, produced a band corresponding to a 698-bp fragment indicative of *B. canis* infection, while PCR Sequence analysis of the products identified *B. canis rossi* and *B. canis vogeli* which happens to be the first report of *B. canis rossi* and *B. canis vogeli* in dogs in Nigeria. Out of blood samples of cattle collected in Abeokuta, Ogun State, *Babesia* spp. was reported (Sam-Wobo et al., 2016). In a study by Egbe-Nwiyi et al (2017), it was observed that *Babesia ovis* was present. A study by Egege et al. (2008) revealed that out of blood samples of dogs, *Babesia species* were positive in the samples. Adejinmi et al. (2004) in a study on the blood parasites of sheep in Ibadan, Nigeria, found out that sheep tested positive for babesiosis. Olufunke et al. (2016) reported from a study that out of 103 blood samples of dogs suspected of babesiosis, 61.1% of the dogs were positive for *Babesia* species. Moses et al. (2020) in a study reported that out of 150 blood smears of dogs, 20 of the dogs were positive with *Babesia canis*. Philip et al. (2020) reported that from 300 blood samples of horses and using species-specific-nested PCR-targeting genes for testing, 10 of samples were positive for *Babesia caballi*.

Anaplasmosis

In Nigeria, a survey on the prevalence of Babesiosis in Cattle and Goats at Zaria Abattoir by Onoja et al. (2013) revealed that out of 223 animals sampled at Zaria abattoir, 168 were cattle and 55 goats. *Anaplasma marginale* was found in cattle (58/168), and *Anaplasma bovis* was found in goats (25/55). Kamani et al. (2010) in a study "the Prevalence and Significance of Haemo-parasitic Infections of Cattle" found that out of a total of 637 blood samples from cattle, *Anaplasma marginale* as a single infection accounted (9%), while in 12 blood samples representing 1.9% there was mixed infection. Mohammed and Idoko (2012), revealed that out of 150 blood samples collected from Sokoto Red goats slaughtered at the Zaria Abattoir and Dogarawa Small Ruminants Slaughter Slab, *Anaplasma bovis* was the most predominant blood parasite detected, 29 (19.3%), using the thin blood smear method in the goats. Isaac et al. (2020) in a study found that out of 200 blood samples of sheep and goat, *Anaplasma ovis* were found to be present, 21 (10.5%). Anyanwu et al. (2016) revealed that *Anaplasma spp.* was present in 12 out of 87 sheep sampled and 37 out of 178 goats sampled. Atsuwe et al. (2018) reported in a study that out of 228 cattle and goat each sampled, the haemoparasites present were *A. centrale* and *A. marginale* in cattle, while in goats, *A. centrale* and *A. marginale*. Qadeer et al. (2015) reported that out of 100 blood samples 4 were positive for *Anaplasma centrale*, while *Anaplasma marginale* were positive in 13 samples. Nwoha et al. (2013a, 2013b) in a study revealed that out of a total of 359 dogs sampled *Anaplasma* spp. were in 160. Vincenzo et al. (2016) reported *Anaplasma platys*, *Anaplasma centrale*, *A. marginale* and *Anaplasma* sp. (Omatjenne) were reported in blood samples of cattle. Adejinmi et al. (2004) in a study reported that out of 214 sheep sampled

24 were positive for *Anaplasma* spp. Imalele et al. (2019) revealed that 4 of cattle tested positive for *Anaplasma* sp. out of a total of 180 cattle sampled from three different locations. Igwenagu, et al. (2018) revealed that out of 100 cattle sampled 7 tested positive for *Anaplasma bovis*. Adua and Idahor (2017) in study revealed out of 80 and 60 blood samples of cattle and goats tested, 7 and 3 were positive for *Anaplasma marginale* and *Anaplasma ovis,* respectively. Elelu et al. (2016) revealed that out of 253 blood samples of cattle, 192 tested positive for *Anaplasma marginale*. Babale et al. (2020) revealed that out of 24 blood samples 22 tested positive for *Anaplasma* sp. Paul et al. (2016) revealed that out of 120 blood samples tested, 7 were positive for *Anaplasma* sp. Mohammed and Idoko (2012) found in a study "Hemoparasites and Hematological Evaluations in Sokoto Red goats slaughtered during the dry Season in Sabon Gari Local Government Area, Kaduna State, Nigeria" that in the 150 blood samples collected from Sokoto Red goats and Dogarawa small ruminants slaughter slab, the blood parasites identified were *Anaplasma ovis* of the blood samples tested. Adamu and Balarabe (2012) reported in a study "Prevalence of Haemoparasites of Sheep and Goats Slaughtered in Bauchi Abattoir" that blood samples collected from 200 animals 100 each of sheep and goats slaughtered at the abattoir were randomly sampled between July and December 2011, and the results showed that *Anaplasma ovis* was in sheep and in goat. Adejinmi et al. (2004), in "Studies on the blood parasites in West Africa Dwarf sheep in Ibadan, Nigeria" found that *Anaplasma* spp. were found in 24 out of a total of 214 blood samples collected. An overall prevalence of 33/200 of *Anaplasma species* was reported in cattle by Wada et al. (2020). In a study on haemoparasite of cattle, a prevalence of 18.5% of Anaplasma species was reported out of 162 blood samples collected (Sam-Wobo et al., 2016).

Theileriosis

Garba et al. (2011) revealed that 41 horses were positive for *Theileria equi* out of 51 horses examined. Anyanwu et al. (2016) reported *Theileria* spp. to be present in 7 out of 87 sheep sampled and 5 out of 178 goats sampled. Atsuwe et al. (2018) reported in a study that out of 228 cattle and dog each sampled, *Theileria ovis* (7.8%) was found to be present in goats. Qadeer et al. (2015) reported *Theileria* spp. 12 were found to be positive out of 100 blood samples collected. Vincenzo et al. (2016) reported that *Theileria velifera* and *T. taurotragi*. Kamani et al. (2010) found 21 blood samples were positive for *Theileria mutans* out of a total of 637 blood sampled tested. Adua and Idahor (2017) revealed that out of 34 blood samples of goats tested, 3 and 6 were positive for *Theileria mutans* and *Theileria ovis*, respectively. Turaki et al. (2014) revealed that out of 100 bloods sampled across three states in Nigeria, 94 were positive for *Theileria equi.* Philip et al. (2020) in a study revealed that *Theileria equi* (39) *and Theileria haneyi* (8) were present out of 300 blood samples of horses tested. Mohammed and Idoko (2012) reported *Theileria ovis* to be positive from 150 blood samples tested. Adamu and Balarabe (2012) in a study on haemoparasite of sheep and goats revealed that *Theileria ovis* was in blood samples of sheeps and in goat. The overall prevalence of *Theileria spp* in cattle slaughtered in Zango abattoir was 22/200 as reported by Wada et al. (2020). *Anaplasma ovis* was reported by Egbe-Nwiyi et al. (2017) in 23 blood samples of sheep and goats in Maiduguri abattoir. A study carried out on the molecular detection of *Theileria* species by Philip et al. (2020) reported that *T. equi* was prevalent in 39 of sampled blood and *T. haneyi* was prevalent in 8 of the blood samples out of a total of 300 blood samples of horses tested.

Rift Valley Fever (RVF)

On July 14, 2017, the Nigeria government reported for the first time to the World Organization for Animal Health (OIE) four outbreaks of Rift Valley Fever Virus (RVFV) with serological test carried out to confirm the cases. The first outbreak occurred in an animal market on the border between Nigeria with Niger in Sokoto State with 63 animals of different species testing positive to the virus. Subsequent outbreaks occurred in other states in the country; in Adamawa State which shares border with Cameroon 11 bovines were positive; in Borno State which shares border with Chad, 64 bovines were positive. The fourth outbreak was reported in Kano State with 305 cattle testing positive (http://www.IZS.it/IZS/first_outbreak_of_Rift_Valley_Fever_in_Nigeria). A study by Adamu et al. (2020) reported that sheep's sampled were found to be seropositive for RVFV. Musa et al. (2021) revealed that camels slaughtered at Maiduguri abattoir had evidence of exposure to RVFV and may serve as source of transmission to other animals. Opayele et al. (2019) reported active RVFV transmission in domestic livestock in Nigeria.

A cross-sectional study on the seropositivity of rift valley fever in pastoral cattle reported that out of 107 cattle breeds sampled an overall prevalence of 6 was reported (Nma et al., 2020); similarly, in a separate study the authors also reported that out of 97 cattle tested 11 were found to be seropositive (Nma et al., 2018). Olaleye et al. (1996) reported that out of 2255 samples, 259 had haemagglutination-inhibiting and neutralizing antibodies in sheeps, goats, cattle, horses and camels. In a study "seroprevalence of rift valley fever virus infection among slaughtered ruminants in Jos, North-Central, Nigeria", it was revealed that out of 100 blood samples collected from livestock cattle (50) and goat (50), 11 was positive for RVF in cattle 8 and in goats 3 were positive (Anejo-Okopi et al., 2020). In a study on one-humped camels in Northern Nigeria, Adamu et al. (2020) reported that an overall prevalence of 143, with older camels between the ages of 6–10 years having a prevalence of 77 out of a total of 720 blood samples tested.

Ehrlichiosis

Ehrlichiosis is an obligate intracellular tick-borne disease that infects different animal species; examples include *Ehrlichia ruminantum* in cattle, *Erhlichia canis* in dogs (Matur et al., 2019; Ogunkoya et al., 2011). Following PCR and reverse line blotting (RLB), 22 blood samples were reported to be positive for *Ehrlichia* or *Anaplasma* spp. (Vincenzo et al., 2016). Similarly, PCR and RLB revealed that out of 100 blood samples collected, 5 with either *Ehrlichia canis or Anaplasma* sp. (Mathew et al., 2014). Matur et al. (2019) in a study using thin blood smear revealed that out of 282 blood samples collected from dogs, 40 were positive for *Erhlichia canis*. *Ehrlichia ewingii* and *Ehrlichia chaffeensis* were detected in a single tick only Anna et al. (2012). There is, however, paucity of information with regard to other forms of *Erhlichiosis* spp. (Table 2).

Economic importance

The economic losses due to *Babesiosis, Anaplasmosis and Theileriosis* have been divided into direct and indirect. The direct production losses are those that are directly attributable to presence of disease in animal population through morbidity and mortality (Jemal, 2017; Latif & Walker, 2016). Other losses are related to the animals that recovered that may suffer from weight loss, lesions such as soft and pulpy spleen, damage and irritation to hide, swollen liver, dark-coloured kidneys, anaemia and jaundice, produce low milk yields, reduction in meat, provide less draught power, and suffer from reduced fertility and delays in reaching maturity (Haranahalli et al., 2014; Jemal, 2017).

Possible factors influencing tick distribution

Animal movement from one ecological zone to another is widely considered as means of introduction of ticks into new ecosystems; the tribes associated with this movement are mostly the Fulani's, and there is also the movement of animals in the wild which can also contribute to distribution (Hassan & Salih, 2013; Ikpeze et al., 2011). Climate change such as desertification, drought, increase or decrease in rainfall and human activities such as deforestation and establishment of large-scale agriculture schemes affect habitats of ticks and hence their existence or non-existence (Hassan & Salih, 2013). Environment characterized by low rain fall is dangerous for tick survival, especially larval stages as they are susceptible to drying out; however, species with seasonal life cycle stand a chance of surviving (Ikpeze et al., 2015). The high infection rate among different animal species could be attributed to their life cycle as some tick species are host specific and free ranging among animals as they cover long distance grazing and crisscrossing vector infested areas and thus bring them in contact with the tick vector, whereas the low infection rate could be attributed to the fact some animals are usually kept in pens which restrict their level of exposure to tick infestation (Pukuma et al., 2011).

Control of ticks and treatment of tick-borne diseases

The economic cost in the control of ticks and tick-borne diseases has to do with the use of acaricides and vaccines; however, there has been emergence of resistant strains of ticks, limitations to the use of chemicals as some might be detrimental to human health (Yakubu et al., 2015). Several concepts such as integrated tick control strategies (host resistance to ticks and diseases they transmit), use of biological control measures, cross-breeding, and the development of vaccines against tick antigen have been deployed in the control of ticks (Jonson & Piper, 2007). Environmental management such as seasonal dynamics of tick infestation and extensive system of raising animals when compared to intensive system increases the risk of tick infestation (Jonson & Piper, 2007, Paul et al., 2017). The most conventional means used in the control

Table 2: Shows the tick-borne diseases and tick species identified

Tick-borne disease	Tick species
Babesiosis	*B. decoloratus, B. annulatus, B. geygyi, B. bigemina, R. saguineus, A. variegatum*
Anaplasmosis	*A. marginale, A. bovis, A. ovis, A. centrale, A. marginale, A. platys*
Theileriosis	*T. equi, T. ovis, T. velifera, T. taurotragi, T. mutans, T. haneyi*
Rift Valley Fever	
Erhlichiosis	*E. ruminatum, E. canis, E. marginale, E. chaffeensis*

of ticks is dipping or spraying with chemicals (Jongejan & Uilenberg, 1994). Commercial Acaricides such as Formamidine, Phenylpyrazole, Synthetic pyrethroids and Macrocyclic lactone were used in an in vitro study against adult *Rhipicephalus (B.) annulatus*, and the Lethal Concentration (LC_{50}) for each was found to be 100, 8000, 2300 and 6000 ppm, respectively (Foluke et al., 2020). In a study on the efficacy of three organophosphates (Chlorfenvinphos, Diazinon and Coumaphos) on different stages of development of *Amblyomma variegatum*, chlorfenvinphos caused the highest mortality rate against all stages of development of the tick specie, while diazinon was the least effective (Natala et al., 2012). Breed of cattle such as Zebu (*Bos indicus*) has been reported to be more resistant to ticks than *Bos indicus* and *Bos taurus* crosses; cross-breeding these cattle with other breeds could lead to a more resistant breed (Musa et al., 2014; Yakubu et al., 2015). Vaccines have been in use in the treatment of tick-borne diseases such as anaplasmosis, babesiosis among other; strains of *Babesia bovis* and *Babesia bigenia* which are more virulent in nature than strain of *Anaplasma marginale* have been used to reduce their virulence. They have been developed in Australia and exported to other countries; there is, however, paucity of information on use of vaccines in Nigeria (Dadson, 1991).

Conclusions

This review shows that tick species of the genera *Amblyomma, Rhipicephalus/Boophilus, Hyalomma, Ixodes, Dermacentor* and *Haemaphysalis* have been reported to be widely distributed in Nigeria. The availability of suitable host, movement of animals from one region of the country to another and favourable climatic conditions are responsible for the spread. Despite paucity of information with regard to the economic cost associated with losses to the livestock industry as a result of ticks and tick-borne diseases, this ectoparasites and the pathogens they transmit are of veterinary and public health concern. Research should be carried out especially as it concerns tick-borne diseases such as Crimean-Congo haemorrhagic fever and Africa tick bite fever among others of public health importance in the country due to lack of documented information. Local development of vaccines should be encouraged through research. Herders should be educated and encouraged to go into ranching in other to reduce cross-border movement of animals which plays a role in the introduction of new species.

Abbreviations

PCR: Polymerase chain reaction; RLB: Reverse line blotting; RVF: Rift valley fever; ECWA: Evangelical church winning all; ECOWAS: Economic Community of West Africa State.

Acknowledgements

Not to be disclosed.

Author contributions

SK, MO, OEI, OO, and KAG contributed immensely in the search for the literature and wrote and also read the manuscript. All authors read and approved the final manuscript.

Funding

None to be disclose.

Availability of data and materials

The datasets generated in the current study are available from the corresponding author.

Declarations

Ethics approval and consent to participate

No ethical was needed; however, they have permission to participate.

Consent for publication

Not applicable.

Competing interests

The authors wish to declare that there are no competing interests.

Author details

[1]Department of Veterinary Parasitology and Entomology, Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria, Nigeria. [2]Department of Pathology, Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria, Nigeria.

Received: 17 February 2022 Accepted: 10 July 2022
Published online: 28 July 2022

References

Abgoola, B. A., Otite, J. R., Ayodele, I. A., & Omonona, A. O. (2022). Tick infestationof Pangolin (*Phataginus tricuspis*) in Omo forest reserve Ogun State, Nigeria. *International Journal of Biodiversity and Endangered Species, 2*, 109.

Adamu, A. M., Enom, S. I., & Ngbede, E. O. (2020). Serosurvey on sheep unravel circulation of Rift Valley Fever Virus in Nigeria. *EcoHealth, 17*, 393–397.

Adamu, B., & Balarabe, L. M. (2012). Prevalence of Haemoparasites of sheep and goats slaughtered in Bauchi abattoir. *IJABR, 4*(1&2), 128–133.

Adang, K. L., Ayuba, J., & Yoriyo, K. P. (2015). Ectoparasites of sheep (*Ovis aries* L.) and goats (*Capra hirus* L.) in Gombe, Gombe State Nigeria. *Pakistan Journal of Biological Sciences, 18*(5), 224–231.

Adejinmi, J. O., Sadiq, N. A., Fashanu, S. O., Lasisi, O. T., & Ekundayo, S. (2004). Studies on the blood parasites of sheep in Ibadan, Nigeria. *African Journal of Biomedical Research, 7*, 41–43.

Adua, M. M., & Idahor, K. O. (2017). Haematological evaluation of Haemoparasites in cattle and goats slaughtered at Lafia Abattoir, Nigeria. *Asian Journal of Biology, 4*(1), 1–5.

Ameen, S. A., Odetokun, I. A., Ghali-Mohammed, L. I., Azeez, O. M., Raji, L. O., & Kolapo, T. U. (2014). Status of ticks infestation in ruminant animals in Ogbomoso Area of Oyo State, Nigeria. *Journal of Environmental Issues and Agriculture in Developing Countries, 6*(2&3), 48–53.

Aminu, M. (2015). A survey of cattle, sheep and goat ticks infestation in Katagum local government area of Bauchi State, Nigeria. *International Journal of Agriculture and Earth Science, 1*(8), 1–5.

Anejo-Okopi, J., Arthur, O. O., Okojokwu, O. J., Joseph, S., Chibueze, G., Adetunji, J., Okwori, J. A., Amanyi, D. O., Ujah, O. I., & Audu, O. (2020). Seroprevalence of Rift Valley Fever Virus infection among slaughtered ruminants in Jos. *North-Central Nigeria*. https://doi.org/10.17582/journal.hv/2020/7.5.109.115

Anna, L. R., Olatunbosun, G. A., Judith, M. H., & Claude, P. M. (2012). Pathogen prevalence in ticks collected from the vegetation and livestock in Nigeria. *Applied and Environmental Microbiology, 78*(8), 2562–2568.

Anyanwu, N. C. J., Iheanacho, C. N., & Adogo, L. Y. (2016). Parasitological screening of Haemo-Parasites of small ruminants in Karu Local Government Area of Nasarawa State, Nigeria. *British Microbiology Research Journal, 11*(6), 1–8.
Arong, G. A., Adetunji, B. A., Mowang, D. A., & Odu, A. E. (2013). Comparative distribution of ticks on dogs in the Calabar Metropolis, South-South Nigeria. *European Journal of Zoological Research, 2*(4), 14–18.
Atsuwe, T. S., Azua, E. T., Obisike, V. U., & Imandeh, G. N. (2018). Comparative study on tick-borne haemoparaites of cattle and goats slaughtered in some abattoirs within Makurdi, Nigeria. *Journal of Applied Life Sciences International, 19*(4), 1–6.
Atsuwe, T. S., Obisike, V. U., Azua, E. T., & Imandeh, G. N. (2019). Prevalence of tick borne haemoparasites in some breeds of cattle and goats slaughtered in some abattoirs within Makurdi, Nigeria. *Journal of Applied Life Sciences International*. https://doi.org/10.9734/jalsi/2019/v21i430110
Babagana, M. A. (2019). Ecology and molecular epidemiology of tick-borne infection in kachia grazing reserve, Nigeria. PhD. Thesis (unpublished), The University of Salford, Manchester, United Kingdom.
Babale, A. D. M., Kuthi, G., Bobbo, A. G., & Mbaya, Y. P. (2020). Prevalence of protozoan parasites in cattle of Madagali Local Government Area of Adamawa State, Nigeria. *Scholarly Journal of Food and Nutrition, 2*(5), 278–281.
Birara, A. T. (2017). Ticks infestation on Cattle in Ethiopia. *Researcher, 9*(12), 55–61.
Biu, A. A., Abdulkadir, M. A., & Isadu, T. H. (2012). Effects of temperature and relative humidity on the egg laying pattern of *Rhipicephalus sanguineus* (Koch, 1844) infesting sheep in semi-arid region of Nigeria. *Sokoto Journal of Veterinary Sciences, 10*(2), 18–20.
Cletus, I. I. (2019). Prevalence of *Rhipicephalus sanguineus* and *Babesia canis* infection among dogs in Ugep, Yakurr Local Government Area of Cross River State, Nigeria. *International Journal of Research and Innovation in Applied Science, 4*(6), 1–6.
Cumming, G. S. (1998). Host preference in African ticks (Acari: *Ixodidae*): A quantitative data set. *B. Entomol. Res., 88*, 379–406.
Dadson, P. K. (1991). Tick-borne diseases of livestock: The need to improve methods for controlling flicks and tickborne diseases. *International Laboratory for Research on Animal Diseases* 9(3):
Daniel, O., Babak, A., Adebowale, A., Anitha, V., Park, E. S., Shuetsu, F., Tomoki, Y., Masayuki, S., Eric, N., Shigeru, M., Roger, H., & Oyewale, T. (2020). Prevalence of antibodies to Crimean-Congo Hemorrhagic Fever Virus in Ruminants, Nigeria, 2015. *Emerging Infectious Diseases, 26*(4), 744–747.
Egbe-Nwiyi, T. N., Sherrif, G. A., & Paul, B. T. (2017). Prevalence of tick-borne haemoparasitic diseases (TBHDS) and haematological changes in sheep and goats in Maiduguri abattoir. *Journal of Veterinary Medicine and Animal Health, 10*(1), 28–33. https://doi.org/10.5897/JVMAH2017.0623
Egege, S. C., Okolocha, E. C., Nwanta, J. A., & Mosimabale, F. O. (2008). Prevalence and seasonality of Babesiosis in dogs treated at a University Veterinary clinic in Kaduna, Nigeria from 1990 to 1999. *Nigeria Veterinary Journal, 29*(3), 21–26.
Ejima, I. A. A., Obayumi, M., Olayemi, I. K., & Dangana, M. C. (2014). Tick Infestation among cattle in Minna Metropolis, Niger State, Nigeria. *Research Journal of Applied Sciences, 9*(3), 126–132.
Elelu, N., Ferrolho, J., Couto, J., Domingos, A., & Eisler, M. C. (2016). Molecular diagnosis of the tick-borne pathogen Anaplasma marginale in cattle blood samples from Nigeria using qPCR. *Experimental and Applied Acarology, 70*(4), 501–510.
Eyo, J. E., Echi, P. C., Atama, C. I., Onyishi, G. C., Ekeh, F. N., Ivoke, N., Nwani, C. D., Obitte, B. C., & Onoja, U. S. (2014). Incidence and prevalence of parasites in exotic suis-large white (Suidae) slaughtered in a tropical urban abattoir. *International Journal of Parasitology Research, 6*(1), 132–135.
Fabiyi, J. P. (2007). Containment of livestock parasites with emphasis on ticks. Nigeria–Australia collaborative Agricultural research. *Aciar proceeding series* No. 4, pp. 67–69.
Foluke, A. A., Ahmed, O. G., & Olubukola, T. A. (2020). *In vitro*Analysis of the efficacy of selected commercial acaricides on the cattle tick *Rhipicephalus* (*Boophilus*) *annulatus* (Acari: Ixodidae). *Egyptian Journal of Veterinary Science, 51*(2), 153–161.
Foluke, A. A., Alex, F. A., Michael, I. T., & Olugbenga, K. O. (2017). Prevalence of *babesia* species in hunting dogs in Ogun State, South West Nigeria. *Alexandria Journal of Veterinary Sciences, 54*, 1–7.
Gad, B. (2019). Babesiosis in dogs-update on pathogenesis, treatment and prevention. Koret School of Veterinary Medicine, The Hebrew University of Jerusalem, Rehovot, Israel. In: Proceedings of the 25th FECAVA Eurocongress (FECAVA Symposium on vector-borne diseases).
Garba, U. M., Sackey, A. K. B., Agbede, R. I. S., Tekdek, L. B., & Bisalla, M. (2011). Serum urea and creatinine levels in Nigerian local horses naturally infected with *Babesia*. *Pakistan Veterinary Journal, 31*(2), 163–165.
Haranahalli, V. M., Buddhi, C. S., Manickam, K., Kumaragurubaran, K., Prakashkumar, R., Marappan, G., Paramasivam, T., & Bharemara, L. B. (2014). Economic importance of ticks and their effective control strategies. *Asian Pacific Journal of Tropical Disease, 4*(2), S770–S779.
Hassan, S. M., & Salih, D. A. (2013). An overview of factors responsible for geographic distribution pattern of ixodid ticks in the Sudan. *Sokoto Journal of Veterinary Sciences, 11*(2), 1–9.
Hector, E., Elelu, N., Ferrolho, J., Couto, J., Sanches, G., Antunes, S., Domingos, A., & Eisler, M. (2019). PCR detection of *Ehrlichia ruminantium* and *Babesia bigemina* in cattle from Kwara State, Nigeria: Unexpected absence of infection. *Parasitology Research*. https://doi.org/10.1007/s00436-019-06204-1
http://www.IZS.it/IZS/first_outbreak_of_Rift_Valley_Fever_in_Nigeria
Igwenagu, E., Onyiche, E. T., Abdullahi, U. F., Maina, M. M., Jatau, S. H., Monguno, M. B., & Kayeri, B. K. (2018). Prevalence of *Anaplasma ovis* and its effects on haematology of apparently healthy Sahel goats in Maiduguri, Nigeria: A preliminary study. *Savannah Veterinary Journal, 1*, 53–57.
Ikpeze, O. O., Eneanya, C. I., Chinweoke, O. J., Aribodor, D. N., & Anyasodor, A. E. (2011). Species diversity, distribution and predilection sites of ticks (Acarina: Ixodidae ontrade cattle at Enugu and Anambra States, Southeastern, Nigeria. *The Zoologist, 9*, 1–8.
Ikpeze, O. O., Eneanya, C. I., & Onyido, A. E. (2015). Burden, Seasonality, Sex ratio and preferred sites of ticks of public health importance on cattle found at Amansea Anambra State Nigeria. *International Journal of Research Granthaalayah, 3*(12), 61–71.
Imalele, E. E., Effanga, E. O., & Usang, A. U. (2019). Haemoparasitic infection and haematological indices of cattle slaughtered for sale in Calabar, Nigeria. *International Journal of Veterinary Sciences and Animal Husbandry, 4*(4), 07–11.
Isaac, D. O., Oluwafemi, B. D., Temitope, U. K., Shola, D. O., Idiat, M. S., & David, O. F. (2020). The Prevalence of Spirochaetes and other Haemoparasites in small ruminants slaughtered at abattoirs in Ilorin Kwara State, Nigeria. *Alexandria Journal of Veterinary Sciences, 5*(1), 1–6.
Jegede, O. C., Obeta, S. S., & Faisal, B. (2014). Infection of dogs with *Babesia canis* in Gwagwalada area of Federal Capital Territory, Abuja, Nigeria. *Sokoto Journal of Veterinary Sciences, 12*(3), 37–41.
Jemal, J. Y. (2017). Review on bovine babesiosis and its economic importance. *Journal of Veterinary Medicine and Research, 4*(5), 1090.
Jesca, N., Joseph, W. M., & Chihiro, S. (2014). Molecular detection of tick-borne pathogens in ticks from Uganda. *Open Access Research, 1*, 767.
Jongejan, F., & Uilenberg, G. (1994). Ticks and control methods. *Revue Scientifique et Technique, 13*(4), 1201–1226.
Jonsson, N. N., & Piper, E. K. (2007). *Integrated control programs for ticks on cattle* (1st ed.). UQ Printery.
Joseph, E. E., Felicia, N. E., & Njoku, I. (2014). Survey of tick infestation of cattle at four selected grazing sites in the tropics. *Global Veterinaria, 12*(4), 479–486.
Kamani, J., Sannusi, A., Egwu, O. K., Dogo, G. I., Tanko, T. J., Kemza, S., Tafarki, A. E., & Gbise, D. S. (2010). Prevalence and Significance of Haemoparasitic Infections of Cattle in North-Central, Nigeria. *Veterinary World, 3*(10), 445–448.
Konto, M., Biu, A. A., Ahmed, M. I., & Charles, S. (2014). Prevalence and seasonal abundance of ticks on dogs and the role of *Rhipicephalus sanguineus* in transmitting *Babesia* species in Maidugiri, North-Eastern Nigeria. *Veterinary World, 4*(3), 119–124.
Latif, A.A., & Walker, A.R. (2016). An introduction to the biology and control of ticks in Africa. *Revised* (unpublished)
Leeflang, P., & Ilemobade, A. A. (1977). Tick-borne diseases of domestic animals in northern Nigeria. I. Historical review, 1923–1969. *Tropical Animal Health and Production, 9*, 147–152.
Lorusso, V., Picozzi, K., de Bronsvoort, B., Majekodunmi, A., Dongkum, C., & Balak, G. (2013). Ixodid ticks of traditionally managed cattle in central

Nigeria: Where Rhipicephalus (Boophilus) microplus does not dare (yet?). *Parasit Vect., 6*, 171.
Lysyk, T. J. (2013). Movement of male *Dermacentor andersoni* (Acari: Ixodidae) among Cattle. *Journal of Medical Entomology, 50*, 977–985.
Mathew, A., Milana, T., David, O. O., Dikeledi, P. M., Barend, L. P., & Paul, T. M. (2014). Occurrence of tick-transmitted pathogens in dogs in Jos, Plateau State, Nigeria. *Parasites and Vectors, 7*, 119.
Matur, B. M., Goselle, O. N., & Idoko, S. O. (2019). Studies on Ehrlichia canis infection on different breeds of dogs in Jos and Bukuru Metropolis of Plateau State, Nigeria. *International Journal of Research in Pathology and Microbiology, 3*(2), 11–13.
Mizuki, S., Olutayo, O., Morito, T., Kaisaku, O., Aya, M., Helen, O. N., Haruyuki, H., Hiromi, I., & Takashi, O. (2007). Molecular survey of *Babesia canis* in dogs in Nigeria. *Journal of Veterinary Medical Science, 69*(11), 1191–1193.
Mohamed, B., Belay, A., & Halilu, D. (2014). Species composition, prevalence and seasonal variations of ixodid cattle ticks in and around Haramaya town, Ethiopia. *Academic Journals, 6*(5), 131–137.
Mohammed, G. I., & Idoko, I. S. (2012). Haemoparasites and Haematological evaluations in Sokoto red goats slaughtered during the dry season in Sabon Gari Local Government Area, Kaduna State, Nigeria. *Nigerian Veterinary Journal, 33*(1), 407–415.
Morel, P. (1989). Tick borne diseases of livestock in Africa. In: Mira Shah-Fischer, Ralph R. Manual of Tropical Veterinary Parasitology, pp. 299–460
Moses, O. O., Israel, J. B., Mayowa, P. O., Waziri, I. A., Victor, H. D. A., Samson, M., Joshua, B. M., & Khalin, S. W. (2020). Prevalence of Canine Babesiosis in Jos South Local Government Area of Plateau State. *Open Access Library Journal, 7*, e6401. https://doi.org/10.4236/oalib.1106401
Murtala, M. A., Yahaya, M., Nma, M. J., Baba, J., Sabitu, M. Z., Joy, F. L., Fatima, A., & Ahmed, K. J. (2020). Fatal human Babesiosis in a nine-year old nigerian girl. *International Journal of Tropical Disease & Health, 41*(10), 26–30.
Musa, H. I., Jajere, S. M., Adamu, N. B., Atsanda, N. N., Lawal, J. R., Adamu, S. G., & Lawal, E. K. (2014). Prevalence of tick infestation in different breeds of cattle in Maiduguri, Northeastern Nigeria. *The Bangladesh Journal of Veterinary Medicine, 12*(2), 161–166.
Musa, H. I., Kudi, C. A., & Gashau, M. M. (2021). Survey of antibodies to Rift Valley Fever Virus and associated risk factors in one-humped camels (*Camelus dromedarius)* slaughtered in Maiduguri abattoir, Borno State, Nigeria. *Tropical Animal Health Production, 53*, 500. https://doi.org/10.1007/511250-021-02956-0
Natala, A. J., Ahembe, T. R., Gberindyer, F. A., Danbirni, S., & Ubani, E. O. A. (2012). Acaricidal Efficacy of Three Organophosphates on Different Stages of *Amblyomma variegatum*. *International Journal of Animal and Veterinary Advances, 4*(2), 76–79.
Nma, B. A., Jibrin, A., Mohammed, K. L., Olutayo, O. B., Ibrahim, G., & Ismail, A. O. (2020). Seropositivity and associated intrinsic and extrinsic factors for Rift Valley Fever Virus occurrence in pastoral herds of Nigeria: A cross sectional survey. *BMC Veterinary Research, 16*(2), 5. https://doi.org/10.1186/s12917-020-02455-8
Nma, B. A., Olutayo, O. B., Yiltawe, W., & Hussaini, G. U. (2018). Participatory survey of Rift Valley Fever in nomadic pastoral communities of North-Central Nigeria: The associated risk pathway and factors. *Plos Neglected Tropical Disease, 12*(10), e0006858. https://doi.org/10.1317/journal.pntd.0006858
Nonyelu, M. I. (2013). The prevalence of haemoparasite infection in dogs attending ECWA veterinary Clinic, Bukuru, Jos South Local Government Area, Plateau State. *Advances in Microbiology, 3*, 302–308.
Nwoha, R. I. O., Daniel-Igwe, G., Onuekwusi, G. C., Onyeabor, A., Igwe, K. C., & Okah, U. (2013a). Incidences of haemoparasites in dogs in Ikwuano Local Government Area of Abia State. *Journal of Veterinary Science and Technology, 4*(4), 141.
Nwoha, R. I. O., Onyeabor, A., Igwe, K. C., Daniel-Igwe, G., & Onuekwusi, G. C. O. (2013b). Prevalence of haemoparasites in livestock in Ikwuano Local Government Area of Abia State. *Journal of Fisheries and Livestock Production, 2*(1), 109.
Obadiah, H. I., Onah, I. E., Ugochukwu, J. U., & Gbinde, A. K. (2017). Tick infestation of cattle in three markets in Makurdi, North-Central, Nigeria. *American Journal of Entomology, 1*(1), 6–10.
Obed, J. D., & Imafidor, H. O. (2018). Haemoparasites of bovine (*Sokoto gudali*) species slaughtered in Port Harcourt Metropololis, Rivers State, Nigeria. *Asian Journal of Biology, 5*(4), 1–8.
Ogunkoya, A. B., Adeyanju, J. B., & Abduhllahi, R. (2011). Experimental and clinical trials of long acting oxytetracycline in the treatment of canine ehrlichiosis. *Veterinary Quarterly, 7*(2), 158–161.
Okwuonu, E. S., Bala, A. Y., & Ikpeze, O. O. (2017). Ixodid tick's infestation of zebu cattle crosses in Sokoto State, Nigeria. *The Bioscientist, 5*(1), 50–56.
Oladipo, T. A., Adekunle, O. F., Okuneye, O. J., Adebayo, M. D., Adeoye, A. T., & Banjoko, O. J. (2015). Pre and post polo competition prevalence of equine babesiosis in stable horses in Ibadan, Oyo state, Nigeria. *International Journal of Research in Agriculture and Forestry, 2*(8), 6–9.
Olaleye, O. D., Tomori, O., & Schmitz, H. (1996). Rift Valley fever in Nigeria: Infections in domestic animals. *Revue Scientifique et Technique, 15*(3), 937–946.
Olufunke, O. A., Rasheed, A. A., Temidayo, O. O., Samuel, O. O., Morenike, A. D., Helen, O. N., & Ebenezer, B. O. (2016). Reliability of clinical monitoring for the diagnosis of babesiosis in dogs in Nigeria. *Veterinary Medicine: Research and Reports, 7*, 85–90. https://doi.org/10.2147/VMRR.S104072
Omudu, E. A., Atu, B. O., & Ayashar, J. G. (2007). Epidemiological survey of Canine Babesiosis in Makurdi, Nigeria. *Animal Research International, 4*(3), 745–749.
Onoja, I. I., Malachy, P., Mshelia, W. P., Okaiyeto, S. O., Danbirni, S., & Kwanashie, G. (2013). Prevalence of babesiosis in cattle and goats at Zaria Abattoir, Nigeria. *Journal of Veterinary Advances, 3*(7), 211–214.
Opara, M. N., & Ezeh, N. O. (2011). Ixodid ticks of cattle in Borno and Yobe States of North-eastern Nigeria: Breed and coat colour preference. *Animal Research International, 8*(1), 1359–1365.
Opayele, A. V., Ndiana, L. A., Odaibo, G. N., & Olaleye, D. O. (2019). Serological evidence of Rift Valley Fever Virus infection in slaughtered ruminants in Nigeria. *Journal Immunoassay Immunochemistry, 40*(4), 364–377. https://doi.org/10.1080/15321819.2019.1609498
Pam, G. R., Hussein, O. A., Akwashiki, O., Hussaini, Y. H., & Cyril, D. N. (2019). Ticks infestation and diversity on indigenous cattle reared in Qua'an Pan LGA of Plateau State, Nigeria. *International Archives of Food and Agricultural Sciences, 1*(1), 17–21. https://doi.org/10.33515/iafas/2019.018/18
Paul, B. T., Amina, M. B., Nasir, M. H., Jamila, D., Deborah, T. O., & Mercy, A. G. (2017). Infestation of Zebu cattle (*Bos indicus* Linnaeus) by hard ticks (Acari: Ixodidae) in Maiduguri, Northeastern Nigeria. *Persian J. Acarol., 6*(3), 213–224.
Paul, B. T., Bello, A. M., Ngari, O., Mana, H. P., Gadzama, M. A., Abba, A., Malgwi, K. D., Balami, S. Y., Dauda, J., & Abdullahi, A. M. (2016). Risk factors of haemoparasites and some haematological parameters of slaughtered trade cattle in Maiduguri, Nigeria. *Journal of Veterinary Medicine and Animal Health, 8*(8), 83–88.
Philip, W. M., Lowell, K., Wendell, C. J., Caleb, A. K., Okubanjo, O. O., Emmanuel, O. B., Edeh, E. R., Emmanuel, O., Kelly, P. S., & Massaro, W. U. (2020). Molecular detection of *Theileria species* and *Babesia caballi* from horses in Nigeria. *Parasitology Research, 119*, 2955–2963.
Pukuma, S. M., James-Rugu, N. N., & Sale, M. (2011). A study on tick borne infections of cattle in Yola locality of Adamawa State. *African Journal of Agricultural Research, 6*(29), 6208–6211.
Qadeer, M. A., Gumel, M. A., Chessed, G., Nganjiwa, J. I., Bernard, K., Vandi, P., Hakim, D., & Fadimatu, U. (2015). A cross sectionnal study on the gastrointestinal and haemoparasites of trade cattle in Girei and Yola North Local Government Areas of Adamawa State, Nigeria. *Journal of Agriculture and Veterinary Science, 8*(4:I), 03–05.
Sam-Wobo, S. O., Uyigue, J., Surakat, O. A., Adekunle, N. O., & Mogaji, H. O. (2016). Babesiosis and Other Heamoparasitic Disease in a Cattle Slaughtering Abattoir in Abeokuta, Nigeria. *International Journal of Tropical Disease & Health, 18*(2), 1–5.
Shola, D. O., Isau, A. G., Karimat, H., & Musa, R. (2018). Occurrence of parasitic diseases of horses in Osun State, Nigeria: A retrospective evaluation. *Alexandria Journal of Veterinary Sciences, 56*(1), 175–181. https://doi.org/10.5455/ajvs.283403
Soulsby, E. J. L. (1982). Healminths, Arthropods Protozoan of domesticated Animals. 7th Edition London, U. K. Bailliere Tindal, pp 456–475
Sylvester, S. O., Bashiru, I., Idris, A. L., Joseph, A. N., Ndudim, I. O., & Emmanuel, O. B. (2020). Prevalence of canine babesiosis and their risk factors among asymptomatic dogs in the federal capital territory, Abuja, Nigeria. *Parasite Epidemiology and Control, 11*, e00186.
Turaki, U. A., Kumsha, H. A., Biu, A. A., & Bokko, P. B. (2014). Prevalence of Piroplasmosis amongst local horses in Northeastern Nigeria. *Journal of Agriculture and Veterinary Science, 7*(12(4)), 04–07.

Vincenzo, L., Michiel, W., Ayodele, O. M., Charles, D., Akinyemi, F., Abraham, G. D., Michael, T., Albert, M., Elise, V., Augustine, C. I., Frans, J., Susan, C. W., & Kim, P. (2016). Tick-borne pathogens of zoonotic and veterinary importance in Nigerian cattle. *Parasites & Vectors, 9*, 217.
Wada, Y., Tijjani, M., Abdulmalik, Y., & Wada, M. (2020). Babesiosis in Cattle slaughtered at Zango Abattoir Zaria, Kaduna State, Nigeria: a short communication. *UMYU Journal of Microbiology Research, 5*(2), 87–91.
Yakubu, A., Yahaya, A., & Omeje, J. N. (2015). Heat tolerance traits and tick infestation in some indigenous breeds of cattle in Nigeria. *Slovak Journal of Animal Science, 48*(2), 79–85.

Publisher's Note