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

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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, excessive 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
(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 unchecked 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 decoloratus*, *Boophilus geigyi*, *Hyalomma rufipes*, *Hyalomma truncatum* and *Rhipicephalus senegalensis*; in sheep, the species of ticks were *Amblyomma variegatum*, *Boophilus decoloratus*, *Boophilus microplus*, *Rhipicephalus sanguinensis* and *Rhipicephalus senegalensis*; in goats *Amblyomma variegatum*, *Hyalomma variegatum*, *Hyalomma truncatum* 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 decoloratus*, *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 pulchellus*) 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 (Obadia et al., 2017). In Sokoto State, the ticks identified in cattle were *Rhipicephalus sanguineous*,

**Other tick-borne diseases**

Other tick-borne diseases that have been reported in Nigeria include *Babesiosis, Theileriosis*, *Anaplasmosis, ehrlichiosis* (Babagana, 2019; Daniel et al., 2020; Hector et al., 2019).
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, Rhipicephalus 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. Ikeeze 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, Haemophysalis leachi and Boophilus decoloratus were identified as ticks of dogs in Cross River State (Arong et al., 2013). Agboola et al. (2022) in a study found tick species 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 (intraerythrocytic 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 as 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

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**Table 1:** Shows the distribution of tick species in Nigeria

| Region          | Northern Nigeria                                                                 | Southern Nigeria                                      |
|-----------------|----------------------------------------------------------------------------------|-------------------------------------------------------|
| Tick species    | A. variegatum, A. spendi, A. lepidum                                             | A. maculatum                                          |
| Amblyomma       | H. rufipes, H. truncatum, H. variegatum, H. impressum, H. impeltatum,            |                                                       |
| Hyalomma        | R. senegalensis, R. sanguinensis, R. evertsi, R. lunulatus                        |                                                       |
| Rhipicephalus   | B. decoloratus, B. microplus, B. annulatus, B. geigyi                             |                                                       |
| Boophilus       | 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 trautmani and Babesia perrucotii 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, Babesia 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. Adejimmi 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 caballi. Philip et al. (2020) in a study revealed Babesia caballi 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. Adejimmi 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. Adejimmi 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. (Omatjenn) were reported in blood samples of cattle. Adejimmi 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 Balabarabe (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. Adejinimi 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 velfera* and *T. taurotragi*. Kamani et al. (2010) found 21 blood samples were positive for *Theileria mutans* out of a total of 637 blood sample 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 Balabarabe (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 Maiduurgi 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 Maiduurgi 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-Onopi 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 ruminantium* in cattle, *Ehrlichia 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 *Ehrlichia 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 *Ehrlichiosis* 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 (Harannahalli 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).

**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. saguinurus, A. variegatum* |
| Anaplasmosis           | *A. marginale, A. bovis, A. ovis, A. centrale, A. marginale, A. platys*         |
| Theileriosis           | *T. equi, T. ovis, T. velifera, T. taur Latin, 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 Macroyclic lactone were used in an in vitro study against adult *Rhipicephalus* (*B.*) *annulatus*, and the Lethal Concentration (LC₉₀) 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 (Musu 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 bigena* 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.

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Availability of data and materials
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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.

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Abbreviations

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