# **INTRODUCTION**

Ticks serve as vectors for many pathogens with significant medical and veterinary relevance. They are obligate hematophagous ectoparasites, responsible for transmitting viruses, bacteria, and protozoa that pose risks to human and animal health (Estrada-Peña et al., 2008; Brites-Neto et al.,2015; Desta, 2016; Kyari et al., 2022). Throughout their lifecycle, ticks must engage with mammalian hosts to obtain the necessary blood meals (Gassner, 2010; Estrada-Peña et al., 2008; Brites-Neto et al., 2015; Desta, 2016). After feeding to repletion, ticks detach from their hosts, enabling them to moult into their next developmental stage. Newly moulted ticks then embark on a quest for another host, during which they may acquire a diverse range of pathogens. The likelihood of ticks acquiring pathogens is influenced by the abundance and distribution of these pathogens within the environment and they are generally most likely to survive and reproduce in tropical climates such as in West Africa (Punyua, 1992; Randolph, 2008; Gassner, 2010; Desta, 2016).

Ticks represent a considerable threat to livestock health and productivity in Nigeria, particularly affecting cattle. These ectoparasites are not only harmful in their own right but also act as vectors for a wide range of pathogens, exacerbating their impact on animal health and the agricultural economy (Desta, 2016; Igwe, 2017). Among the various tick genera that infest cattle in Nigeria, *Amblyomma, Boophilus*, *Hyalomma*, and *Rhipicephalus* are frequently encountered (Fasanmi & Onyima, 1992; Igwe et al., 2017; Kyari et al., 2022). These ticks inflict direct harm by feeding on the blood of cattle, leading to anaemia, irritation, and stress, which subsequently reduce productivity in terms of milk yield, weight gain, and overall health. Furthermore, their role as vectors for pathogens, including bacteria, viruses, and protozoa, poses an additional challenge for livestock management (Kyari et al., 2022). For example, *A. variegatum* and *R. microplus* are known for their capacity to transmit pathogens such as *Ehrlichia ruminantium*, the causative agent of heartwater disease, further underscoring the significant threat posed by tick infestations in the region (Muramatsu et al., 2005; Robinson et al., 2009; Some et al., 2023). Sometimes, the ticks are particularly found in specific predilection sites of the cattle, raising levels of direct destruction and irritation to the area. For example, the well-known *A. variegatum* is very frequently found in the genital and breast areas of cattle (Stachurski, 2000). Although there is clear evidence of widespread tick infestations in cattle ranches and markets across Nigeria, efforts to control these ectoparasites remain insufficient (Igwe, 2017; Ikpeze et al., 2011). The nomadic cattle-rearing system commonly practised in Nigeria likely contributes to the propagation of ticks across regions, as herds are constantly on the move (Adamu et al., 2005). This movement raises questions about the biogeographic spread of ticks in the country, since climatic differences between regions may affect the survival and continuation of their species.

In Southern Nigeria, cattle are predominantly reared and traded by Fulani and Hausa men, with most herds groomed in the northern region before being transported to the South and other parts of the country (Adamu et al., 2005; Jones, 1946; Stenning 1957). This large-scale movement of cattle, facilitated by interstate transportation, nomadic farming practices, and trade markets, increases the likelihood of cross-infestation of ticks between regions. Despite this, there is a noticeable lack of monitoring and control efforts in most areas. The first documented study of cattle ticks in Edo State, Southern Nigeria, was conducted by Adane et al. (2019), which reported a high prevalence of tick infestations (21.5%), including the presence of the invasive *R. microplus*. However, integrated pest management strategies to address this issue remain largely absent. Many cattle herders, particularly nomadic ones, do not use acaricides to manage tick infestations in their herds (Adehan et al., 2018; Adenubi et al., 2020). Since that initial study, no follow-up research has been conducted, leaving a significant gap in understanding the current state of tick infestations. Ongoing cattle trade and transportation have probably worsened the situation, leading to the further spread of ticks, the introduction of new exotic tick species, and an increased prevalence of both newly introduced and pre-existing tick species across Nigeria. We are carrying out this study to examine the state of tick infestation present at a trade cattle market in Edo State, Nigeria. As an update to existing literature, we would determine the level of prevalence and the species richness of ticks present. Furthermore, we would investigate how these ticks differ in abundance across predilection sites of cattle.

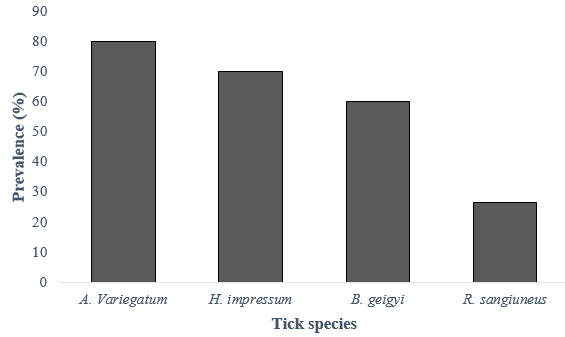
# **RESULTS**

A total of 510 ticks were collected from the 30 cattle inspected. The ticks belonged to four (4) distinct species: *Amblyomma variegatum* (189), *Hyalomma impressum* (229), *Boophilus geigyi* (83) and *R. sangiuneus* (9). The number of ticks collected across the predilection sites is presented in Table 1. The highest collections were made from the belle (99) and the least from the shoulders (63). Overall, 24 cattle were affected in at least one predilection area of their body, resulting in a prevalence of 80%. Furthermore, *A. variegatum* was the most prevalent tick species (80%) followed by *H. impressum* (70%), as shown in Figure 1.

Interestingly, the infected cattle had multiple infestations from different tick species (Table 2). 13.3% of cattle surveyed had all 4 species of ticks’ infestation and 63.3% of cattle had at least three (3) distinct species of ticks parasitizing them. Also, all 24 infected cattle were infested with *A. variegatum*. Additionally, 21 cattle had *H. impressum* infestations, while *B. geigyi* and *R. sanguineus* were found on 18 and 8 cattle, respectively.

**Table 1**: Ticks collected from the six predilection sites of cattle at trade market, Edo state.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Predilection site | *A. Variegatum* | *H. impressum* | *B. geigyi* | *R. sangiuneus* | Total |
| Belly | 41 | 35 | 20 | 3 | 99 |
| Head | 24 | 51 | 9 | 4 | 88 |
| Leg | 48 | 30 | 13 | 0 | 91 |
| Neck | 29 | 46 | 6 | 1 | 82 |
| Shoulder | 21 | 31 | 10 | 1 | 63 |
| Tail | 26 | 36 | 25 | 0 | 87 |

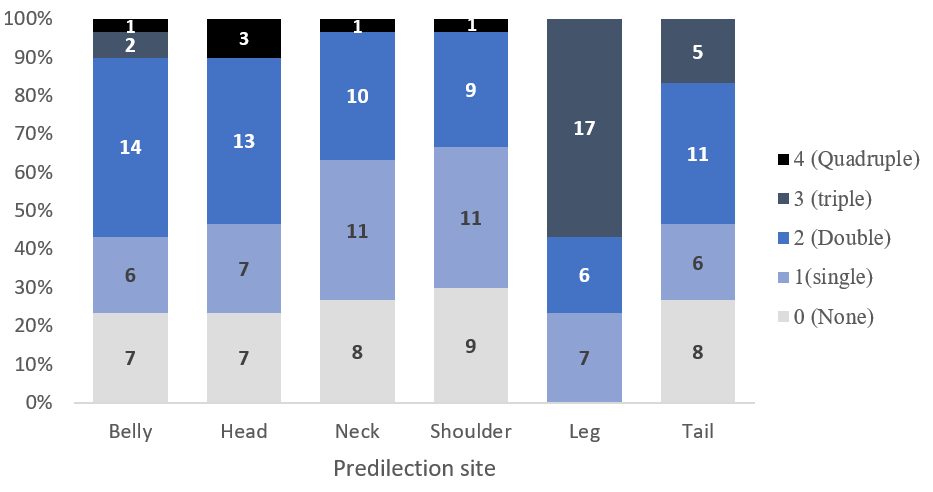


**Figure 1**: Overall prevalence (%) of ticks from cattle (n=30) at trade market, Edo state.

Table 2: Single and multiple tick infestations in the cattle.

|  |  |  |
| --- | --- | --- |
| Number of Tick Species | Number of cattle infested | Prevalence (%) |
| 1(single) | 0 | 0 |
| 2 (Double) | 5 | 16.7 |
| 3 (triple) | 15 | 50 |
| 4(Quadruple) | 4 | 13.3 |

While most of the cattle sampled for tick infestations had multiple tick infestations, some disparities when checked for per predilection site (Figure 2). All cattle had at least one (1) tick species infestation on their legs, with 17 cattle having triple tick species infestation. Moreover, there were 7-9 cattle without any tick infestation at the predilection sites except the legs. Also, Head, neck, shoulders and belly of the cattle had quadruple infestations (i.e., infestations from the four distinct species of ticks), with 10% of cattle having all four tick species present in the head and the other quadrupled-tick-infested sites from just one cattle each.



**Figure 2**: Number of cattle and their respective number of distinct tick species infestation. *The bars are colour-graded from light to dark(er) with respect to the level of zero to multiple tick species infestations. The stacked column bar chart represents the count of cattle in their relative abundance (%) for each predilection site. Numbers within the bars represent actual counts of cattle with 0-4 distinct tick species in the respective predilection site. None: Zero tick infestation; Single: 1 tick species infestation; Double: 2 tick species infestation; Triple: 3 tick species infestation; Quadruple: 4 tick species infestation.*

# **DISCUSSION**

In this study, we examined cattle at a trade market in Edo State, Nigeria, to determine the prevalence of tick infestation. We focused on six predilection sites of the cattle’s bodies—head, neck, shoulder, belly, legs, and tail—and assessed the presence of zero, single, and multiple (taxonomically distinct) tick species. This research is crucial because the last published study by Adane et al. (2019) reported a high prevalence of tick infestations, but no subsequent studies have been conducted. Our findings showed an overall tick prevalence of 80%, meaning that out of the 30 cattle surveyed, at least 24 were infested with one or more tick species. This prevalence is about four times higher than the 21.5% reported by Adane et al. (2019), who reportedly conducted a whole-body count for tick infestations on each cattle. Similarly, high prevalence rates have been recorded previously; for instance, Musa et al. (2014) observed a prevalence of 63.4% among 205 cattle surveyed in Maiduguri, Nigeria. In this study, we examined six predilection sites to test for consistency in findings on tick prevalence. Interestingly, the legs were the only predilection site where at least one tick was consistently found across all cattle; in contrast, 7–9 cattle were free of infestation at other predilection sites. Notably, three cattle had all four tick species infesting their heads, resulting in quadruple tick species infestations. This pattern was also observed in one cattle each for the shoulder, neck, and belly. However, it is important to note that most of the sampled cattle legs exhibited triple-tick species infestations.

In our study, *H. impressum* was the most abundant tick species collected across all cattle examined, though it ranked second to *A. variegatum* in infestation prevalence (Figure 1). Musa et al. (2014) similarly reported high levels of *Hyalomma* spp. in their inspection of 205 cattle for ticks in Maiduguri, Nigeria, predominantly in the eye, ears, inner thighs, and tail regions. However, *H. impressum* was absent from the findings of Adane et al. (2019). Onyiche et al. (2020) recorded low numbers (n=2) of *H. impressum* from camels examined in Kano, Northwest Nigeria, identifying it as the least prevalent of five *Hyalomma* species collected in that study. Similarly, Mamman et al. (2021) reported nine (9) *H. impressum* among 240 ticks collected in Zamfara and fifteen (15) out of 254 ticks collected from cattle in Sokoto, Nigeria. These ticks are of significant veterinary concern, particularly because *H. impressum* has been identified as a vector of *Theileria annulata*, a parasite causing tropical theileriosis, a severe disease affecting cattle predominantly in North Africa and Asia (Hashemi-Fesharki, 1988; Liu et al., 2022).

*A. variegatum* was the second most abundant tick species observed in our study and the most prevalent tick (80%) infesting the cattle we sampled. This finding aligns with numerous studies across West Africa that have documented similarly high occurrences and infestation rates of this species in cattle (Lorusso et al., 2013; Compaoré et al., 2022; Hayatou, 2023). For instance, *A. variegatum* was reported as the most prevalent tick (76%) in a study conducted by Akande et al. (2017) at a cattle ranch in Ogun State, Nigeria. Likewise, Paul et al. (2017) documented a high prevalence of this tick, recording 798 individuals (37.7%) from a sample of 500 cattle in Maiduguri, North-Eastern Nigeria. In contrast, Adene et al. (2019) reported a relatively lower abundance of *A. variegatum* compared to three other tick species surveyed in their study. While we observed a prevalence of *A. variegatum* as high as 80%, Adene et al. (2019) found a considerably lower overall prevalence of just 17.58%.

*B. geigyi* infested 60% of cattle in this study which is concerning, knowing that they have high potential to carry cattle diseases. They can transmit bacteria such as *Staphylococcus pyogenes* and *Pseudomonas aeruginosa*, through their eggs and larvae (Amoo et al., 1987; Kyari et al., 2022). Also, *R.* *sangiuneus* is not a common tick in Southern Nigeria, however, it has been reported in the Northern region in dogs and cattle. Adejoh et al. (2019) documented a relatively low prevalence of this tick species, identifying it in only 0.5% of 200 cattle examined, the lowest prevalence among all tick species encountered.

It can be argued that the high prevalence of ticks observed in our study may be temporally related to the timing and seasonality of sample collection. Adene et al. (2019) noted the highest abundance of ticks occurring between May and July, which aligns with our sampling period conducted in June and July. Nevertheless, the prevalence in our study was significantly higher, suggesting that additional, unaccounted-for factors may contribute to the observed occurrence. For example, a study by Musa et al. (2014) revealed that younger cattle, specifically those under the age of three years, exhibited a significantly higher prevalence of tick infestation at 85.4%, compared to adult cattle aged between three and seven years, which had a prevalence of 55.8%. Additionally, Musa et al. (2014) observed that cattle over seven years old experienced the lowest prevalence of tick infestation, recorded at 35.0%. The study further examined the variation in tick prevalence across different cattle breeds, finding that the Wadara and Kuri breeds exhibited higher prevalence rates compared to the Rahaji, Gudali, and Bunaji breeds. These cattle breeds are particularly prevalent in Edo State, located in Southern Nigeria, which is also the region where this study was conducted.

We acknowledged that larger cattle are likely to have a greater external body surface area for ticks to attach to, making cattle size a potential factor influencing our findings on overall tick prevalence and abundance at the predilection sites. Rehman et al. (2017)’s study showed that larger livestock had a higher abundance of ticks compared to smaller ones, in their comparison between cattle, buffalo, goats and sheep. They also found that female livestock generally carried a higher number of ticks compared to their male counterparts. Additionally, other variables such as cattle age, breed, and phylogenetic background likely affect their susceptibility to tick infestations (Rehman et al., 2017). Despite these considerations, the consistently high prevalence of ticks observed raises critical questions about the extent to which local vector control efforts are targeted at these ectoparasites.

The observed high tick prevalence and multiple species infestation in our study highlights a critical concern regarding the control and management of tick infestations in the region. The high prevalence of ticks in our study may be attributed to the trade market setting, where cattle from diverse regions converge, increasing the chances of cross-infestations. Additionally, the absence of rigorous tick control measures in trade markets could contribute to the observed high infestation rates. Although we did not observe the invasive *R. micropylus* in this study, unlike Adene et al. (2019), research in Cameroon suggests its establishment is facilitated by intense cattle trade (Lontsi-Demano et al., 2020). Additionally, the presence of multiple tick species on individual cattle raises the risk of co-infections, worsening disease severity and complicating treatment (Andersson et al., 2017).

The findings of this study highlight an urgent need for improved tick control measures in Edo State and other regions of Nigeria. Integrated tick management strategies, including regular acaricide treatments, rotational grazing, and the growing of tick-resistant cattle breeds, could be prioritized. Public awareness campaigns targeting cattle owners and traders can also play a vital role in reducing tick infestations and associated health risks. Collaborative efforts between veterinary authorities, researchers, and policymakers are essential to develop and implement sustainable tick management programs that address the specific challenges faced by cattle farmers in Nigeria.

# **Conclusion**

This study serves as an updated record to the state of tick infestation in cattle in Edo State, Nigeria. Tick infestations in cattle are poorly monitored and this is concerning, especially since ticks are of great medical, veterinary and economic importance to Nigeria. We find four tick species in a distinct genus: *A. variegatum, H. impressum. B. geigyi* and *R.* *sangiuneus*. To the best of our knowledge, this study represents the first documented report of *H. impressum* infesting cattle in Edo State, Nigeria. Interestingly, most of the cattle had multiple tick species infestations—even at specific predilection areas. On examination of the predilection site of cattle, we find that the legs contained the most tripled-tick-species infestation. This multi-species infestation and the high level of tick prevalence in cattle are of great public health importance and necessitate a rapid response by the government, vector control agencies and animal monitoring agencies to look into this issue.

# **REFERENCES**

Adamu, F., Filani, M., & Mamman, A. B. (2005). Market and transport institutions in Nigeria’s livestock trade: Case studies from Sokoto and Ibadan. PORTER, Gina, FERGUSON, Lyon and The Nigerian Marketing Network. Investigations on Building a Food Marketing Policy Evidence Base in Nigeria. CNTR, 4(5785), 35-58.

Adane, I. O., Okaka, C. E., Aiwaritoma, A. O., Osagie, P. A., & Igetei, J. E. (2019). Prevalence and seasonal variation of ticks in trade cattle consumed in EDO state, Nigeria. Prevalence, 4(5).

Adehan, S. B., Adakal, H., Gbinwoua, D., Yokossi, D., Zoungrana, S., Toé, P., ... & De Clercq, E. M. (2018). West African cattle farmers’ perception of tick-borne diseases. EcoHealth, 15, 437-449.

Adejoh, V. A., Pam, V. A., Uzoigwe, N. R., Naphtali, R. S., Yohanna, J. A., Pam, R. G., & Ombugadu, A. (2019). A survey of ticks and tick-borne parasites in commercial cattle at Lafia, Nasarawa State, Nigeria. Nigerian Journal of Parasitology, 40(2).

Adenubi, O., Salihu, T., Mbaoji, C. O., Ojogbo, I. A., & Abdullahi, M. (2020). A review of ethnoveterinary botanicals used for tick control in Wukari, Taraba State, North Eastern Nigeria. Egyptian Journal of Veterinary Sciences, 51(3), 421-437.

Akande, F. A., Oyewusi, I. K., Ajisafe, M. G., Idowu, O. A., & Anifowose, I. O. (2017). Survey of cattle tick infestation on farm herds in Ogun state, Nigeria. Nigerian Journal of Animal Production, 44(3), 23-30.

Amoo, A. O., Dipeolu, O. O., Akinboade, A. O., & Adeyemi, A. (1987). Bacterial isolation from and transmission by Boophilus decoloratus and Boophilus geigyi. Folia Parasitologica, 34(1), 69-74.

Andersson, M. O., Víchová, B., Tolf, C., Krzyzanowska, S., Waldenström, J., & Karlsson, M. E. (2017). Co-infection with Babesia divergens and Anaplasma phagocytophilum in cattle (Bos taurus), Sweden. Ticks and tick-borne diseases, 8(6), 933-935.

Brites-Neto, J., Duarte, K. M. R., & Martins, T. F. (2015). Tick-borne infections in human and animal population worldwide. Veterinary world, 8(3), 301.

Compaoré, S., Boungou, M., Biguezoton, A. S., Thiombiano, N. G., Zannou, O. M., Ouedraogo, A. S., & Kabré, G. B. (2022). Tick species infesting cattle in the central region of Burkina Faso: Presence of Rhipicephalus microplus less than ten years after its first identification in the Southwest part of the country. Ticks and Tick-borne Diseases, 13(5), 101983.

Desta, B. G. E. A. H. (2016). Review on the impact of ticks on livestock health and productivity. J. Bio. Agr. Health, 6, 1-7.

Estrada-Peña, A., Venzal, J. M., Kocan, K. M., & Sonenshine, D. E. (2008). Overview: ticks as vectors of pathogens that cause disease in humans and animals.

Fasanmi, F., & Onyima, V. C. (1992). Current concepts in the control of ticks and tick-borne diseases in Nigeria—A review. International Journal of Tropical Insect Science, 13(4), 615-619.

Gassner, F. (2010). Tick tactics: interactions between habitat characteristics, hosts and microorganisms in relation to the biology of the sheep tick Ixodes ricinus. Wageningen University and Research.

Hashemi-Fesharki, R. (1988). Control of Theileria annulata in Iran. Parasitology Today, 4(2), 36-40.

Hayatou, H., Meutchieye, F., Amarir, F. E., Rhalem, A., Bouslikhane, M., & Awah-Ndukum, J. (2023). Prevalence of Tick Infestations and Tick-Borne Diseases in Cattle in Cameroon. Open Journal of Animal Sciences, 13(4), 560-573.

Igwe, O. H., Emmanuel, O. I., Uju, U. J., & Keghnen, G. A. (2017). Tick infestation of cattle in three markets in Makurdi, North-Central, Nigeria. American Journal of Entomology, 1(1), 6-10.

Igwe, O. H., Emmanuel, O. I., Uju, U. J., & Keghnen, G. A. (2017). Tick infestation of cattle in three markets in Makurdi, North-Central, Nigeria. American Journal of Entomology, 1(1), 6-10.

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) on trade cattle at Enugu and Anambra States, south-eastern Nigeria. Zoologist (The), 9, 1-8.

Jones, G. I. (1946). The Beef-Cattle Trade in Nigeria. Africa, 16(1), 29-38.

Kyari, S., Ogwiji, M., Igah, O. E., Orakpogheno, O., & Gasaliyu, K. A. (2022). Current distribution and disease association of Ixodidae (hard ticks) in Nigeria. The Journal of Basic and Applied Zoology, 83(1), 42.

Kyari, S., Ogwiji, M., Igah, O. E., Orakpogheno, O., & Gasaliyu, K. A. (2022). Current distribution and disease association of Ixodidae (hard ticks) in Nigeria. The Journal of Basic and Applied Zoology, 83(1), 42.

Liu, J., Guan, G., & Yin, H. (2022). Theileria annulata. Trends in parasitology, 38(3), 265-266.

Lontsi-Demano, M., Ngnindji-Youdje, Y., Laroche, M., Bamou, R., Talom, A. D., Abah, S., ... & Tchuinkam, T. (2020). Cattle trading favors the introduction and establishment of the invasive tick Rhipicephalus (Boophilus) microplus in Menoua Division, West Region of Cameroon. J. Entomol. Zool. Stud, 8, 207-214.

Lorusso, V., Picozzi, K., de Bronsvoort, B. M., Majekodunmi, A., Dongkum, C., Balak, G., ... & Welburn, S. C. (2013). Ixodid ticks of traditionally managed cattle in central Nigeria: where Rhipicephalus (Boophilus) microplus does not dare (yet?). Parasites & vectors, 6, 1-10.

Mamman, A. H., Lorusso, V., Adam, B. M., Dogo, G. A., Bown, K. J., & Birtles, R. J. (2021). First report of Theileria annulata in Nigeria: Findings from cattle ticks in Zamfara and Sokoto States. Parasites & vectors, 14(1), 242.

Muramatsu, Y., Ukegawa, S. Y., El Hussein, A. R. M., Rahman, M. B. A., Gabbar, K. M. A. A., Chitambo, A. M., ... & Tamura, Y. (2005). Ehrlichia ruminantium, Sudan. Emerging Infectious Diseases, 11(11), 1792.

Musa, H., Jajere, S., Adamu, N., Atsanda, N., Lawal, J., Adamu, S., & Lawal, E. (2014). Prevalence of Tick Infestation in Different Breeds of Cattle in Maiduguri, Northeastern Nigeria. Bangladesh Journal of Veterinary Medicine, 12(2), 161–166. https://doi.org/10.3329/bjvm.v12i2.21279

Onyiche, T. E., Răileanu, C., Tauchmann, O., Fischer, S., Vasić, A., Schäfer, M., ... & Silaghi, C. (2020). Prevalence and molecular characterization of ticks and tick-borne pathogens of one-humped camels (Camelus dromedarius) in Nigeria. Parasites & Vectors, 13, 1-16.

Paul, B. T., Bello, A. M., Haruna, N. M., Dauda, J., Ojo, D. T., & Gadzama, M. A. (2017). Infestation of zebu cattle (bos indicus linnaeus) by hard ticks (acari: Ixodidae) in maiduguri, northeastern Nigeria. Persian Journal of Acarology, 6(3).

Punyua, D. K. (1992). A review of the development and survival of ticks in tropical Africa. International Journal of Tropical Insect Science, 13, 537-544.

Randolph, S. E. (2008). The impact of tick ecology on pathogen transmission dynamics.

Rehman, A., Nijhof, A. M., Sauter-Louis, C., Schauer, B., Staubach, C., & Conraths, F. J. (2017). Distribution of ticks infesting ruminants and risk factors associated with high tick prevalence in livestock farms in the semi-arid and arid agro-ecological zones of Pakistan. Parasites & vectors, 10, 1-15.

Robinson, J. B., Eremeeva, M. E., Olson, P. E., Thornton, S. A., Medina, M. J., Sumner, J. W., & Dasch, G. A. (2009). New approaches to detection and identification of Rickettsia africae and Ehrlichia ruminantium in Amblyomma variegatum (Acari: Ixodidae) ticks from the Caribbean. Journal of medical entomology, 46(4), 942-951.

Some, M. V., Biguezoton, A. S., Githaka, N., Adakal, H., Dayo, G. K., Belem, A., ... & Chevillon, C. (2023). The potential of Rhipicephalus microplus as a vector of Ehrlichia ruminantium in West Africa. Ticks and Tick-borne Diseases, 14(2), 102117.

Stachurski, F. (2000). Invasion of West African cattle by the tick Amblyomma variegatum. Medical and Veterinary Entomology, 14(4), 391-399.

Stenning, D. J. (1957). Transhumance, migratory drift, migration; patterns of pastoral Fulani nomadism. The Journal of the Royal Anthropological Institute of Great Britain and Ireland, 87(1), 57-73.