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ORIGINAL ARTICLE

Abundance of Ticks in Pasture at Nnamdi Azikiwe University, Awka

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ABSTRACT
Cattle incursion inNnamdi Azikiwe University (UNIZIK) premises Awka necessitated thispioneer study on abundance of ticks on pasture in UNIZIK. Twenty quadrats, each measuring 40m²were delineatedin UNIZIKand sampled for ticksbetween April 2011and March 2012, using a modified blanket dragging method. Ticks (n=1441)encounteredwere in the percentagesAmblyommaspp. (42.1%), Boophilusspp. (26.9%), Hyalommaspp. (9.7%) and Rhipicephalusspp. (21.3%). Wet and dry seasons' mean densities were1.06±0.46 and 0.74±0.6 ticks/m², with correspondingSimpson's Dominance Indexof D=0.3216 (D¹=3.11) and D=0.5362(D¹=1.86). However Shannon Diversity IndicesH=0.5379(wet season) and H=0.5666(dry season)confirmedno significant difference in seasonaldiversity of the ticks (t=2.8475, df=143.08, P>0.001). UNIZIK environmentwith 'tick hot spots' is a risk factor for tick-bites and potential transmission of tick-borne infectious diseases (TBD) to humans. Resultsfrom this study will create public awareness on these risks as well as serve useful purpose informulation of evidence-based policy on surveillance of TBDand control of cattle menace in the study area.
Keywords: *Cattle, University premises, tick-bite, TBD surveillance, controlled grazing.*

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INTRODUCTION

Ticksare blood-feeding external parasites of vertebrates and are arachnids in the order Ixodidain which approximately 850 to 900 species have been described worldwide [1].Ticks infestations on cattle, sheep, goats and horses has been investigated by various authors in Nigeria[2, 3, 4, 5, 6, 7, 8, 9 and 10];and because ticks can remain on hosts for days at a time, they are readily translocated during host movement [8] and when introduced in new areas [11] may constitute a major public health hazard and affect the role of wild life in the maintenance of natural foci of tick-borne infectious diseases [12, 13]. People visiting potential tick-bite exposure areas (tick hot spots) are reported to be important epidemiological factors in TBD infectious [14, 15]. Ticks known to have been introduced by cattle grazing from northern Nigeria tothe south, and through cattle trade include *Amblyomma, Boophilus, Hyalomma, and Rhipicephalus* species [8]. It is therefore imperative that Scientists monitor the activities that may bring humans, livestock and wildlife in close contact so as to prevent the spread of TBD [16, 17 and 18].

Infrastructural developments in and on the outskirts of Awka Capital Territory in Anambra State, Nigeria contributes to shortages in availability of pasture and water necessary for cattle grazing in that area. Nnamdi Azikiwe University (UNIZIK) located on the outskirts of Awka, has large expanse of pasture and perennial shallow water bodies which attract nomadic cattle. UNIZIK Management Committee (UMC) had expressed concernover the activities of herdsmen who invaded the university premises for cattle grazing [19]. Cattle incurtion into UNIZIK premises could introduce ticks, withhigh risks of infectious tickbites that may transmit TBD among UNIZIK populace. Studies of ticks in apparently non-TBD endemic areas might therefore provide useful information on abundance and seasonal distribution of ticks, which was the major aim of this study in UNIZIK premises Awka, southern Nigeria.

MATERIALS AND METHODS

UNIZIK is situated on the northern side of the Onitsha – Enugu Federal Highway, about 60km from Enugu and 35km East of Onitsha. Lying within Latitude 6˚14´N to 6˚14.5´N and Longitude 7˚8.6´E to 7˚9´E, UNIZIK is built on an area spanning over 502 hectares, with a vast expanse of land for development and expansion. Key indicators of cattle activitieseasily observedwithin UNIZIK's environment includedearly-mornings odour of methane gas, hoof marks, dung, and over-grazed pasture.Transhumant pastoralist activities in UNIZIK have also been reported by University Management Committee [19]. Twenty 40m^2 quadrats were delineated from each of the 20 locations of overlapping human and cattle activities observed in UNIZIK. Each quadrat was sampled monthly for 12 months, using modified dragging method[9]in which lightly-coloured blanket materialswere dragged over each of the quadratsto attrack ticks. Blanket materials were inspected immediately and ticks recovered from each quadrat were placed in separately labeled jam jars containing 70% alcohol which slowly killed and preserved the specimens. Specimens were subsequently identified to species or genera levels according to [20].Abundance, mean abundance and density of ticks in pasture were determined according to [21]. Simpson's Dorminance Index (D) and Shannon-Wiener Diversity Index (H) were computed according to [22] while the reciprocal form (D^1) of Simpson's index that defines the number of very abundant species was adopted to ensure that D^1 increases with increasing diversity [23, 24]. Method for calculating *t*that tested for significant difference between samples [25] was employed to establish any significant difference in seasonal diversity of the ticks encountered in UNIZIK premises.

RESULTS AND DISCUSSIONS

Samples sites showing the intensity of cattle and human activities are shown in Table 1.

Table 1: Samples sites showing the intensity of cattle and human activities

S/N	*Description\ locationof sampled site*	*Cattle activity*	*Human activity*
1	Pasture and forest on and around the University Stadium	Very high	High
2	Pasture around the University Beautiful Gate	Very high	Very high
3	Farmland and cattle entry\exitI route by Ifite side of UNIZIK	Very high	Very high
4	Farmland and cattle entry\exitI route by Amansea side of UNIZIK	Very high	Very high
5	Grassland at New Education Department Building Site	Very high	Very high
6	Grassland at New Economics Department Building Site	Very high	Very high
7	University Nursery\Primary School Field and tracks towards Science Village	High	Very high
8	Stream and Farmland between Social Sc. and Management Sciences Faculty	High	High
9	Forest behind Science Village	High	Low
10	Farmland opposite Work's Department	Low	Very high
11	University Nursery\Primary School premises	Low	Very high
12	Streamlet by New Economics Department Building Site	Low	High
13	Pasture between Chisco Institute and Professor Nwakor Digital Library	Low	High
14	Play ground besides Professor Dora Akunyili Hostel and Plant House	Low	Very high
15	Farmland behind Professor Nwakor Digital Library	Low	High
16	Streamlet between University Nursery\Primary and Main Auditorium	Low	Low
17	RufaiGaruba Quadrangle	Very low	Very high
18	University High School field	Very low	Very high
19	General Biology Laboratory Quadrangle	Very low	Very high
20	Afrihub ICT Quadrangle	Very low	Low

Mean seasonal abundance and density of genera of ticks in pasture at UNIZIK are shown in Table 2.

Table 2: Seasonal abundance and density of genera of tickssampled on different sites in UNIZIK

Sites sampled	Wet season (April-October 2011)						Dry season (November 2011-March 2012					
	A	*B*	*H*	*R*	∑	D	*A*	*B*	*H*	*R*	∑	D
1	36	26	5	13	80	2.00	22	19	8	12	61	1.52
2	30	27	5	9	71	1.77	18	16	7	10	51	1.27
3	29	21	2	16	68	1.70	25	22	8	13	68	1.70
4	29	23	5	11	68	1.70	26	24	10	14	74	1.85
5	26	9	6	16	57	1.42	23	20	7	10	60	1.50
6	26	9	6	16	57	1.42	20	18	6	10	54	1.35
7	26	19	4	6	55	1.37	10	9	3	6	28	0.70
8	21	11	2	10	44	1.10	16	13	5	11	45	1.12
9	21	9	2	9	41	1.02	15	10	4	6	35	0.87
10	22	3	6	9	40	1.00	7	0	2	2	11	0.27
11	17	6	4	8	35	0.87	5	6	2	6	19	0.47

12	16	6	3	10	35	0.87	8	7	3	5	23	0.57
13	16	4	3	10	33	0.82	10	9	3	6	28	0.70
14	15	7	2	7	31	0.77	6	6	1	4	17	0.42
15	17	4	2	8	31	0.77	2	2	1	1	6	0.15
16	13	3	2	7	25	0.63	0	3	0	0	3	0.07
17	10	2	4	7	23	0.57	2	2	0	0	4	0.10
18	8	2	3	8	21	0.52	2	1	0	0	3	0.07
19	6	3	3	6	18	0.45	0	0	0	0	0	0.00
20	6	6	1	5	18	0.45	0	0	0	0	0	0.00
Total abundance	390	200	70	191	851		217	187	70	116	590	
Mean abundance	19.50	10.0	3.50	9.55	42.55		10.84	9.35	3.5	5.8	29.5	
Density (tick/m^2)	0.49	0.25	0.09	0.24	1.06		0.27	0.23	0.09	0.15	0.74	

A=*Amblyomma* species, *B* =*Boophilus* species, *H* =*Hyalomma* species, *R*=*Rhipicephalus* species, D= density. Total abundance = Total no. of individuals, Mean Abundance = Total abundance÷number of quadrats sampled, Density = Mean Abundance ÷ the area of each quadrat, according to [21].

Some of the tick 'hot spots'with overlapping cattle and human activitiesare depicted in Plate 1.

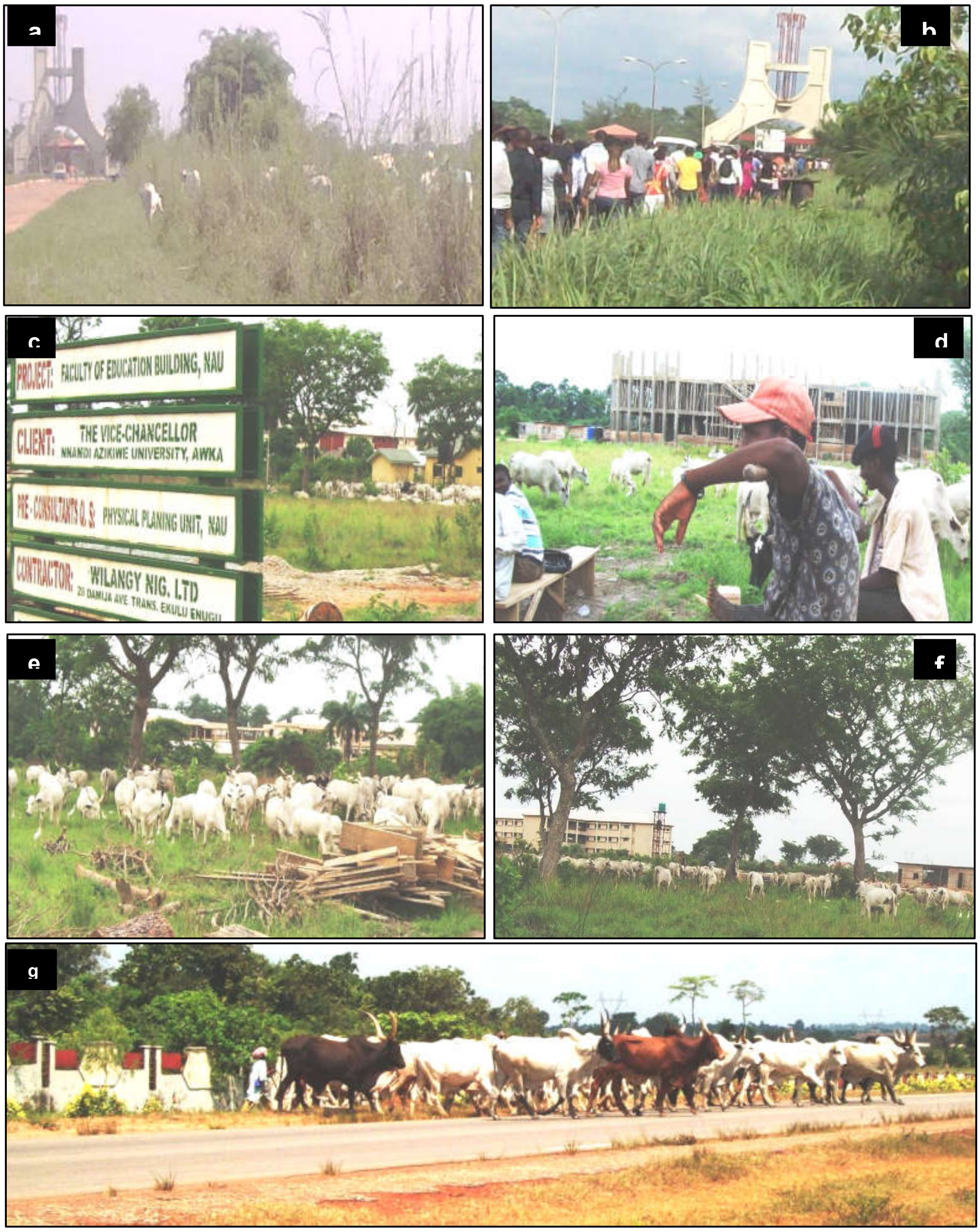

Plate1: Someof the areas of overlapping cattle and human activities sampled for ticks in UNIZIK.

Beautiful Gate [a.b], New Faculty of Education site[c, d], Site over-looking the Faculty of Management Sciences [e], Prof. Dora Akunyili Female Hostel [f], Cattle emerging from University Stadium [g].

This study identified four genera of ticks, namely, *Amblyomma* sp., *Boophilus* spp., *Hyalomma* spp., and *Rhipicephalus* spp. on cattle and pasture in UNIZIK. These ticks have been reported to be ubiquitous on cattle and other domestic animals in Nigeria [2, 7, 8, 10, 26, and 27]. Also [28] recovered *Amblyomma* spp., *Boophilus*spp. and *Hyalomma*spp. from cattle in Bukuru near Jos in northern Nigeria. Dogs in Makurdi Nigeria were also infested with *Boophilus annulatus* and *Hyalomma truncatum*[29] while [30] reported that *Hyalomma* spp., *Amblyomma variegatum* and *Rhipicephalus* spp. are the common hard ticks found on one-humped camel (*Camelus dromedaries*) in Kano State. *Amblyomma variegatum* was also identified on chickens in Nigeria [31] and in Malawi [32].

Trends of mean seasonal densities of ticks in pasture at sampled locations in UNIZIK are shown in Fig. 1.

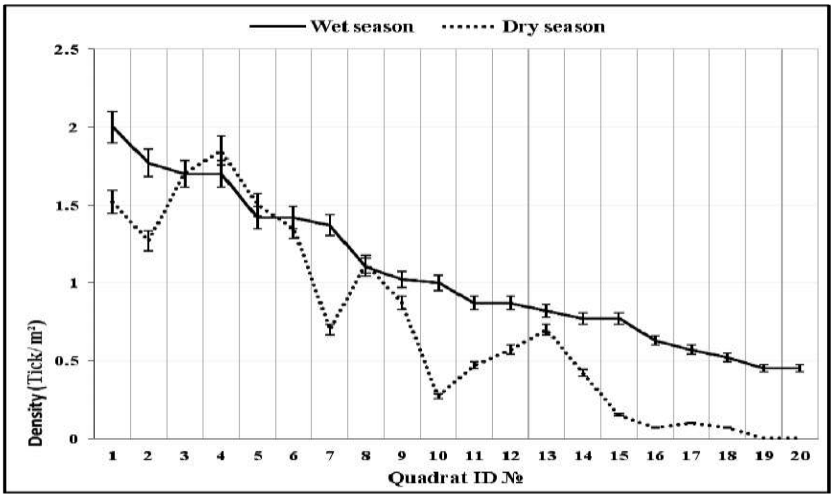

Figure1: Mean Seasonal density of ticks per meter squared sampled in UNIZIK

Computations for the easonal diversity and dominance indices for ticks encountered in pasture at UNIZIK are shown in Table 3 while Table 4 shows the values of Shannon-Wiener and Simpson Dominance Indices as well test for significant differences in seasonal diversity of the genera of ticks identified.

Table 3: Computations for Diversity and Dominance Indices for genera of ticks encountered in UNIZIK

Season	Species	(*fi*)	*fi log fi*	*filog²fi*	*pi = ni/N*	*ni*(*ni-1*)/*N*(*N-1*)
Wet season (April to Oct 2011)	*Amblyomma*	390	1010.515	2618.3102	0.4583	0.2097
	Boophilus	200	460.206	1058.9478	0.2350	0.0550
	Hyalomma	70	129.157	238.3071	0.0823	0.0067
	Rhipicephalus	191	435.677	993.7946	0.2244	0.0502
	∑	N = 851	2035.555	4909.3597	1.0000	0.3216
Dry season (Nov2011- Mar 2012)	*Amblyomma*	217	507.012	1184.6125	0.3678	0.1349
	Boophilus	187	424.834	965.1564	0.3169	0.1001
	Hyalomma	70	129.157	238.3071	0.1187	0.0139
	Rhipicephalus	116	239.477	494.3905	0.1966	0.2873
	∑	N = 590	1300.480	2882.4665	1.0000	0.5362

ni = *fi* = no. of individuals in the *ith* species, *N* = no. of individual (the total abundance), *pi* = *ni*/*N*.

Table 4: Seasonal diversity indices of genera of ticks encountered in UNIZIKcalculated from Table 3

Indices		Wet season	Dry season
Shannon-Wiener Diversity Index (H)	$H = (N \log N - \sum fi \log fi)/N$	0.5379	0.5666
Simpson Dominance Index (D)	$D = \sum ni(ni-1)/N(N-1)$	0.3216	0.5362
Reciprocal of D =D¹ = 1/D defines the number ofvery abundant species		3.1100	1.8600

Since H is now known, we determined t, that tested for significant difference between seasonal diversity, using the method adopted by Hutcheson (1970)

$t = H_1 - H_2/\sqrt{(S^2H_1 + S^2H_2)}$ (Hutcheson, 1970), where, S^2H = Variance H = $\{\sum fi \log^2 fi - (\sum fi \log fi)^2/N\}/N^2$ Degrees of freedom $df = (S^2H_1 + S^2H_2)^2/[(S^2H_1)^2/N_1 + (S^2H_2)^2/N_2]$.

Var. H_1 for wet season = $\{4909.3597 - (2035.555)^2/851\}/(851)^2 = 0.000055786$

Var. H_2 for dry season = $\{2882.4665 - (1300.480)^2/590\}/(590)^2 = 0.000045803$

$t_{cal} = 0.5666 - 0.5379/\sqrt{(0.000055786 + 0.000045803} = 2.8475$

df = $(0.000055786 + 0.000045803)^2/[(0.000055786)^2/851 + (0.000045803)^2/590] = 143.08$

$tcrit_{0.001, 143} = 3.359$.

Since t_{cal} (2.847) < $tcrit_{0.001, 143}$ (3.359), there is no significant difference (*P*> 0.001) between diversity of ticks in wet and dry seasons at UNIZIK.In a similar study carried out on local and cross-bred cattle in Asella Town southeast Ethiopia [33], the genus *Amblyomma* spp., *BoophilusRhipicephalus*, and *Hyalomma*spp. were identified. *Amblyomma* spp. and *Rhipicephalus*s pp. were also reported from cattle in MizanTeferi Southwest Ethiopia [34], and in Assosa Town Ethiopia only *Amblyomma* spp., *Boophilus*spp. and *Rhipicephalus*spp. were identified [35]. Prevalence of cattle in Punjab, Pakistan showed that *Hyalomma* species of ticks were most abundant, followed by *Boophilus* spp. and *Rhipicephalus*spp. but no *Amblyomma* species[36]. In North of Iran, according to [37], the predominant genera were *Hyalomma*spp. and *Ornithodoros* spp. in the arid habitats; *Ixodes* spp and *Boophilus*spp. in forest areas; *Haemaphysalis* spp. and *Dermacentor*spp. in most other habitats while *Amblyomma* spp. was not identified. These results show that ticks found in UNIZIK were also widely spread on cattle and other domesticated animals in Africa, Pakistan and Iran.

Over 90% of Nigeria's estimated 12.3 M cattle were distributed in the savannah zone of Northern Nigeria [38]sothis study inferred that tick-infested cattle derived from northern parts of Nigeria were responsible for the introduction ticks in the study area.This is in line with the panel on animal health [39]conclusion that animal movements played great impact on the spread of ticks and tick-borne diseases. Public health importance of the genera *Amblyomma* spp., *Boophilus* spp., *Hyalomma* spp., and *Rhipicephalus*spp.found in UNIZIK, as well as the economic loss they cause in livestock production in Nigeria have been reported by [38]in 1992. *Amblyomma variegatum* causes dermatitis, transmits *Cowdria ruminantum* (agent of heart water disease in ruminants), virus of Q fever (*Coxiella burneti*), and *Dermatophilus congolensis* responsible for Cutaneous Strepthothricosis that damages hides and skin of Nigeria's cattle [40, 38], *A. variegatum* also transmits *Rickettsia africae*, the causative agent of African Tick-bite fever, reported to be present in many countries in Sub-Saharan Africa [41]; and has been detected by PCR in Nigeria by [42] who reported that the density of tick pathogens in Nigeria was higher in feeding than in questing ticks, suggesting that cattle with herd infection rate of 20.6% for a *Rickettsiaafricae*-like species serve as reservoirs for at least some tick-borne pathogens. The role of *Boophilus* species in human babesiosis has been elucidated by [43, 44] while the incidence and economic significance of equine babesiosis in Lagos and Ibadan, Nigeria have been reviewed [45, 46]. *Hyalomma* species are reported to be primary vectors for CCHF virus that is endemic throughout Africa [46] while *Hyalomma truncatum*, incriminated as vectors of Q fever, are also responsible for tick paralysis in Africa [20]. In Pakistan, ticks were also reported to be responsible for reduction in production, infertility, disease and death [47].In Equatorial Africa, all stages of *Rhipicephalus appendiculatus* feed throughout the year, resulting in inter-stadial transmission of pathogens, especially *Theileriaparvaparva* that causes Theileriosis, a very deadly disease of cattle [48].

This study corroborated the reports that in Tropical Africa, infestation rate and tick burden decreased during the dry season and increased during the rainy season [33, 49]. It also agrees with the findings that the population of ticks on animals was higher during the rainy months than the dry months in Jos, Nigeria [50] while tick burden decreased during the long dry season and increases after short rainy season in Assosa Ethiopia [35]. In a similar study carried out in Jimma Zone, Ethiopia [51], *Amblyomma* spp. Occurred throughout the year, but was greater at the beginning and end of the rainy season. It was also explained [51] that high humidity and temperature were the factors that influenced these seasonal variations - *Amblyomma*spp. is highly dependent on moist environment because of its great susceptibility to percentage losses of total body water, and drop in hemolymph volume at low humidity. According to [52] changes in rainfall are predicted to have little effect on *Boophilus*spp.(which in any case is a one-host tick that is much less exposed to ambient conditions than *Amblyomma*spp.(and other three-host ticks) but they show a clear effect on *Hyalomma* spp.(a two-host tick). In Equatorial Africa all stages of *Rhipicephalus appendiculatus* feed throughout the year [53, 54] but marked declines in abundance of all stages occur simultaneously during the dry season [55].

Spatial ranking of intensity of cattle activity in UNIZIK revealed that more cattle presence, hence more intensity of activity, were observed around the portals of entry and exit, near the streams and extensive grassland areas with tree covers. Geo-climatic conditions of these areas would naturally supported ticks in line with the findings that macro and micro-climate needed for the sustenance of ticks include high enough population density of hosts (e.g., cattle and wildlife) and high enough humidity for ticks to remain hydrated [56]. The perennially flowing shallow streamlets, tree canopies, extensive pasture and well-aerated soil, as well as the average monthly ambient temperature (27.4^{o}C), relative humidity (80%), soil temperature (29.7^{o}C) and average of 63 rainy days in UNIZIK (personal communications, Department of GeoMet UNIZIK) are very conducive for cattle grazing and ticks' survival and development.

Expectedly, density of ticks at different sample locations positively correlated with spatial ranking of intensity of cattle activity in UNIZIK. Density of questing ticks would be a direct measure of the density of cattle on pasture. The seasonal variation of ticks on the animals may present a direct association with the availability of larvae in the pasture but increased host density may reduce the density of questing tick population [57]. However during the periods of low infestation on cattle such as in the dry season, the population of larvae available in the pastures may be relatively low [58] but high abundance of questing ticks were observed in areas with high cattle activities in UNIZIK but this may not guarantee their attachment and feeding success or survival [57] because if ticks run out of body fat before finding a host they will die [55], though under favourable warm, moist conditions, prolonged questing will increase the probability of finding a host, thereby exhausting the questing tick population more rapidly. Nevertheless, *Amblyomma* species was the dominant species in pasture at UNIZIK, where the environmental conditions are very favourable for the development and sustenance of *Amblyomma* species and larvae of *Boophilus* species, the second dominant species in pasture.In UNIZIK, with areas of overlapping human and cattle activities (Plates 1), there is a high risk of ticks biting human in the study area.

CONCLUSION

Ticks identified in UNIZIK belong to the genera well-known as vectors of Tick-borne Disease (TBD) pathogens in sub-Saharan Africa and Nigeria. Theirpresence constitute potential danger to public health, since cattle and human activities occur frequently on potential tick-bite exposure areas in UNIZIK. Result of this study will highlight the abundance ticks in pasture at UNIZIK, create awareness on health hazards posed tick-bites, andwill be useful in the formulation of evidence-based policy decisions on vector control and restricted cattle movement.

DISCLOSURE OF INTEREST

All authors declare that they have no conflicts to report.

ANIMAL STUDIES

No animal or human studies were carried out by the authors.

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