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PREVALENCE AND IDENTIFICATION OF TICKS IN CATTLE OF RAJSHAHI, BANGLADESH

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ABSTRACT

Ticks, the notorious ectoparasite, are frequently infest cattle and cause various disease conditions and acts as vector of pathogenic organism. To determine the tick infestation in cattle of four Districts of Rajshahi Division, Bangladesh, a total of 1200 cattle (300 from each district) were randomly examined throughout the year. Four hundred ticks (100 from each district) collected from cattle were microscopically identified to determine the prevalence of specific ticks. Among the examined cattle, 433 (36.08%) were found infested with one or more species of ticks. The highest prevalence was recorded in Naogaon District (39.66%) followed by Rajshahi (37.33%), Joypurhat (34.33%) and Natore (33%). Tick infestation rate was higher ($p<0.05$) in rainy season (43%) followed by summer (37.75%) and winter (27.5%). Adult cattle (>5 years) were significantly ($p<0.05$) susceptible (41.63%) to tick infestation in comparison to young (>1-<5 years) (29.94%) and calves (<1 year) (34.13%). Significant difference ($p<0.05$) was observed in sex related infestation. Female were highly susceptible (48.31%) than male (19.92%). Local breed cattle were significantly susceptible (41.97%) compare to North Bengal Gray (37.28%) and cross breed (26.60%) cattle. Ear was the most favorite (72.51%) infestation site of tick whereas least was found in scrotum (5.31%). Microscopic identification revealed 5 different species of ticks. *Boophilus/ Rhipicephalus microplus* was the most prevalent (33.5%) species followed by *Haemaphysalis bispinosa* (23.50%), *Amblyomma variegatum* (17.25%), *Rhipicephalus sanguineus* (14%) and *Hyalomma anatolicum anatolicum* (11.75%). Notable tick infestation in cattle indicated the possibility of damaged by ticks and opportunity of transmission of pathogenic organism. Thus, an effective control strategy is warned to overcome the harmful effects of ticks on cattle.

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INTRODUCTION

Ticks are notorious blood sucking ectoparasites distributed throughout the world particularly in tropical and subtropical countries including Bangladesh. Tick and tick borne diseases (TTBDs) affect about 80% of the world cattle population (Ghosh et al., 2007a; 2007b). Ticks have great pathogenic importance to man and animals because of transmission of different vector borne diseases. Tick transmits a number of deadly diseases caused by different types of organisms (Virus, Bacteria, Rickettsia, and Protozoa etc.). They are acts as potential vectors as well as reservoirs of certain infectious agents important for human such as *Pasteurella multocida*, *Brucella abortus* and *Salmonella typhimurium* (Jongejan and Uilenberg, 2004). Ticks also transmit different zoonotic diseases like borreliosis, tick borne encephalitis, relapsing fever or Rocky Mountain spotted fever (Gray, 1998).

Cattle plays significant role in agro-based national economy of Bangladesh. Heavy infestation of ticks in cattle is characterized by irritation of the skin, rubbing the body against fixed object, inflammation, corrugation and scale formation on the affected part, anemia, loss of hair, hyperkeratosis, toxicosis, allergy, depression, hypersensitivity, abscesses, weight loss, lameness, paralysis and in severe cases death (Bekele et al., 2011; Soulsby, 1982). Ticks may cause considerable reduction in the milk production in dairy cows (Peter et al., 2005). Each female *Boophilus microplus* is able to ingest 1.0 ml of blood from the host cow, approximately 1g weight loss and 8.9 ml milk production reduced daily (Luciana et al., 2011). It was recorded that, 23% of milk yield per day reduce when crossbred Holstein-zebu cows are infested with an average of 105 ticks (Haranahalli et al., 2014). Cattle infested with an average of 40 ticks/day losses the body weight up to 20 kg/year and also diminished hides value 20-30% (Frisch et al., 2000). Tick infestation results poor quality of hides and skin. They may also cause paralysis and toxicosis which greatly hampered the cattle production in endemic areas. Tick infestation reduces the export of the most profitable raw materials and causes great annual financial losses in Bangladesh (Kabir et al., 2011).

Two clinically important protozoan diseases of cattle viz. babesiosis and theileriosis and a rickettsia disease anaplasmosis is biologically transmitted by tick. The various degree of morbidity of these diseases results economic losses and even death of the infected individual (Kettle, 1995). According to some local preliminary survey, Bangladesh is frequently affected by different species of ticks (Razzak and Shaikh, 1969; Qader and Huq, 1973; Rahman and Mondal,, 1983). The available tick species identified in different areas of Bangladesh were *Boophilus microplus, Riphicephalus sanguineus, Haemaphysalis bispinosa, Hyalomma anatolicum anatolicum and Amblyomma variegatum* (Kabir et al., 2011; Haque et al., 2011; Kamal et al., 1996; Islam et al., 2006; Mohamed et al., 2014). On the other hand, haemoprotozoan diseases of cattle have also been recorded from some districts of Bangladesh (Samad et al., 1983). A very little sporadic study was conducted on tick infestation in cattle of northwestern Bangladesh, but there is no precise information about infestation status. Thus, it is very rational to know the actual information regarding prevalence of ticks in cattle and identification of ticks infested. This will be helpful to establish a sustainable tick control program. This study revealed the current scenario of tick infestation in cattle of the study area and identify the important tick species which were frequently infested the native and cross breed cattle.

MATERIALS AND METHODS

Study area, Data and Sample collection

Four districts of Rajshahi division namely Rajshahi, Natore, Naogaon and Joypurhat were selected as study area to collect tick samples from cattle (Figure 1). For collection of ticks, the cattle of the study area were examined physically throughout the year. The data and tick samples were collected according to age, sex, breed of cattle. During collection, the site of infestation was also recorded. To determine the seasonal variation, the samples were collected in consideration of 3 different seasons namely summer, winter and rainy. The unfed and engorged ticks of all three stages (larvae, nymph and adult) were collected carefully from different body parts of cattle with the help of fingers. Vigilances were taken during collection so that the appendages and mouthparts of tick remain intact without any damages.

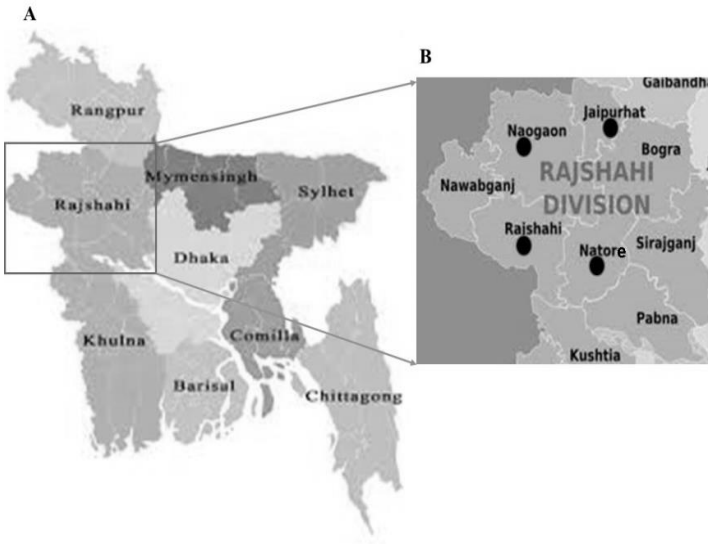

Figure 1. Map of study area. A) Map of Bangladesh indicating Rajshahi division. B) Study area indicated by black circle

Selection and separation of tick specimens

The collected tick samples were preserved in a labeled falcon tube containing 70% ethyl alcohol and transported to the laboratory of the Department of Veterinary and Animal Sciences, University of Rajshahi. The preserved tick specimens were taken into different labeled petridishes for different study areas. Fed and unfed ticks were selected and separated into another labeled falcon tube containing 70% ethyl alcohol for next steps. Some ticks were discarded whose mouthparts and appendages were damaged during collection.

Identification of tick species

Ticks were identified presumptively by compound microscope fitted with Olympus digital camera with 4X objective according to the keys and description mentioned in textbook (Soulsby, 1982; Walker et al., 2003). The most prominent features that were focused on deciding to identify a particular species of ticks are length of mouthparts, shape of basis capituli, presence of scutum or conscutum, ornate or inornate, presence or absence of festoons, adanal plates and anal groove in each species. The presumptive identification of tick species was confirmed by permanent slides preparation according to the procedure described by Nelson (Nelson, 2001). Briefly, the ticks were placed in a falcon tube containing 10% KOH solution to dissolve keratins followed by washing with distilled water to remove KOH. To remove water, the specimens were passed sequentially through graded ethanol of 70%, 80%, 80%, 90%, 95% and finally 100% for 15 minutes in each step. Acid Fucshin stain was added to tick specimens for 15 minutes while they are in 70% ethanol. Following dehydration, the tick specimens were soaked in xylene on a petridish before mounting. After placing of specimen on a clean sterilized glass slide, the specimen was covered with coverslip using Canada Balsam. The mounting agent was allowed to harden and the excess agents were cleaned with a red hot-scalpel. The slides were dried very slowly over a slide dryer for several days. The permanent slides were labeled on the left side including the name of tick and date. Finally, the prepared slides were stored in a light slide box away from heat and light for future examination.

Statistical analysis

All data recorded in this research were entered into Microsoft excel 2007. Prevalence was estimated according to the formula of Thrusfield (2005). Association between different variables such as season, age, sex and breed and outcome variable (tick infestation status) was done using Chi-square test ($\chi 2$) test. In this research, all statistics were considered significant at $p<0.05$ level. Odds ratio was calculated according to the formula of Schesselman (1982).

RESULTS

Prevalence and identification of tick species

A total of 1200 cattle were randomly examined throughout the year from different study area of which 433 (36.08%) cattle were infested with different species of ticks (Table 1). Prevalence of tick infestation in cattle was non-significantly ($p<0.05$, $\chi2= 3$, df = 3) highest in Naogaon District (39.66%) followed by Rajshahi (37.33%), Joypurhat (34.33%) and lowest in Natore District (33%) of Bangladesh (Figure 2). Prevalence of specific tick species were determined by random identification of 100 ticks from each district (total 400) (Table 2). Tick species were microscopically identified by specific identifying characteristics of each species. The prevalence of *Boophilus/Rhipicephalus microplus* was (33.50%), *Rhipicephalussangiuneus* was (14%), *Haemaphysalis bispinosa* was (23.50%), *Hyalomma anatolicum anatolicum* was (11.75%) and *Amblyomma variegatum* was (17.25%) (Figure 3). *B. microplus* was identified by the presence of hexagonal basis capituli and absence of festoons. Male *Boophilus* had distinct caudal process and adanal plates. Ratio of male and female *B. microplus* was 1:2.62. *R. sanguineus* had hexagonal basis capituli and festoons. Absence of adanal plate in male differentiates it from female. The male and female ratio of *R. sanguineus* was 1:0.8. Rectangular basis capituli, ornamentation and festoons were the characteristics for *H. bispinosa*. Female was identified by the absence of adanal plate. The identification ratio of male and female *H. bispinosa* was 1.41:1. Crescent shape basis capituli, ornamentation, festoons and spiracular plate were specific for *H. anatolicum* species. Presence of ventral plate in *H. anatolicum* male distinctly separates it from female. The identification ratio of male and female *H. anatolicum* was 1:1.61. Long mouth parts, ornamentation on entire scutum and festoons were the characteristics of *A. variegatum*. Ventral plate, accessory shield or subanal shield were absent in male. The identification ratio of male and female *A. variegatum* was 1:0.76. (Figure 4, 5; Table 3).

Table 1. Tick infestation in cattle of different districts (300 cattle from each district)

Study area	Non-infested	Infested
Naogaon	181	119
Rajshahi	188	112
Natore	201	99
Joypurhat	197	103
Total	**767**	**433**

Table 2. Species specific tick infestation in cattle of four districts ((100 ticks from each district))

Districts	Tick species				
	Boophilus microplus	*Riphicephalussan guineus*	*Haemaphysalis bispinosa*	*Hyalomma ana. anatolicum*	*Amblyomma variegatum*
Rajshahi	28	13	26	11	22
Naogaon	39	11	24	12	14
Natore	24	17	23	16	20
Joypurhat	43	14	21	9	13

Table 3. Male female ratio of ticks infested in cattle

No. of Ticks	Species Identified	Sex ratio		
		Male	Female	Male: Female
400	*B. microplus*	37	97	1:2.62
	R. sanguineus	31	25	1:0.8
	H. bispinosa	55	39	1.41:1
	H. ana. anatolicum	18	29	1:1.61
	Amblyomma variegatum	39	30	1:0.76

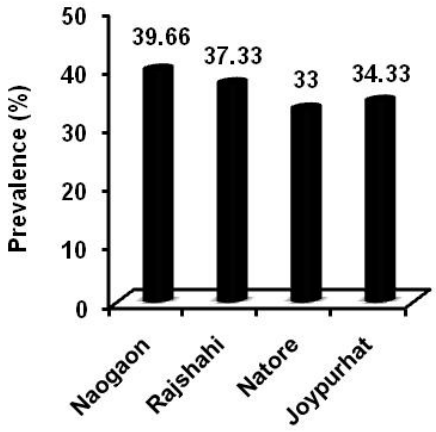

Figure 2. Prevalence of tick infestation in cattle of different districts

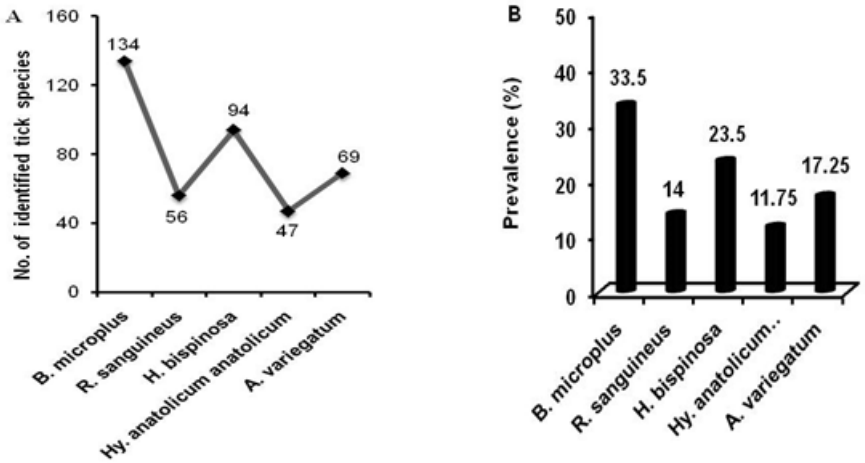

Figure 3. Species specific tick infestation in cattle.

A) Number of identified tick species, **B)** Prevalence (%) of different species of ticks

Figure 4. Identification of ticks under microscope (Fresh sample, Olympus microscope at 4X).
a, b: *Boophilus microplus* female (Dorsal view-a, ventral view-b), c, d: *Boophilus microplus* male (Dorsal view-c, ventral view-d),
e, f: *Haemaphysalis bisponosa* female (Dorsal view-e, ventral view-f),
g, h: *Haemaphysalis bisponosa* male (Dorsal view-g, ventral view-h), i, j: *Hyalomma anatolicum anatolicum* female (Dorsal view-i, ventral view-j),
k, l: *Hyalomma anatolicum anatolicum* male (Dorsal view-k, ventral view-l), m, n: *Rhipicephalus sanguineus* female (Dorsal view-m, ventral view- n),
o, p: *Rhipicephalus sanguineus* male (Dorsal view-o, ventral view-p),
q, r: *Amblyomma variegatum* male (Dorsal view-q, ventral view-r),
s, t: *Amblyomma variegatum* female (Dorsal view-s, ventral view-t)

Figure 5. Identification of ticks under microscope (Processed sample, Olympus microscope at 4X).
a. *Boophilus microplus* male (ventral view),
b. *Rhipicephalus sanguineus* male (ventral view),
c. *Haemaphysalis bispinosa* female (ventral view),
d. *Haemaphysalis bispinosa* male (ventral view),
e. *Hyalomma anatolicum anatolicm* male(ventral view), f. *Hyalomma anatolicum anatolicm* female(ventral view), g. *Amblyomma variegatum* female (ventral view),
h. *Amblyomma variegatum* male

Seasonal variation of tick infestation in cattle

It was observed that, seasons were significantly ($p<0.05$) influence the rate of tick infestation in cattle of the study area. Prevalence of tick infestation was significantly ($p<0.05$, $\chi2= 21$, $df= 2$) highest in rainy season (July-October) (43%) followed by in summer (March-June) (37.75%) and lowest in winter season (November-February) (27.50%) (Figure 6). In rainy season, cattle were 1.24 times more susceptible to tick infestation than summer and 2 times than winter. In summer season, cattle were 1.61 times more susceptible to tick infestation than winter (Table 4).

Table 4. Seasonal variation of tick infestation in cattle

Season	Cattle examined	Infested Cattle				Odd ratio
		Calves	Young	Adult	Total	
Summer	400	33	45	73	151	R vs S 1.24
Rainy	400	43	52	77	172	R vs W 2.0
Winter	400	24	22	64	110	S vs W 1.61

R: Rainy; W: Winter; S: Summer

Age wise tick infestation in cattle

In this research, the age of cattle was categorized into three groups i.e. calves (<1 yrs), young (>1- <5 yrs) and adult (>5 yrs). The prevalence of tick infestation was significantly ($p<0.05$, $\chi2= 13$, $df= 2$) highest in adult >5 years (41.63%), followed by in calves <1 years were (34.13%) and lowest in young>1-<5 years (29.94%) (Figure 7). It was observed that, adult cattle were 1.66 times more susceptible to tick infestation than young and 1.38 times than calves. Calves were 1.21 times more susceptible to tick infestation than young (Table 5).

Table 5. Tick infestation in cattle of different age groups

Age (yrs)	Cattle examined	Infested	Non-infested	Odd ratio
Calves (<1)	290	99	191	C vs Y 1.21
Young(>1-<5)	384	115	269	A vs Y 1.66
Adult (>5)	526	219	307	A vs C 1.38

C: Calves; Y: Young; A: Adult

Sex related tick infestation in cattle

The prevalence oftick infestation was analyzed in cattle of both sexes. It was observed that the prevalence of tick infestation was significantly ($p<0.05$, $\chi2= 104$, $df= 1$) higher in female (48.31%) than in male (19.92%) (Figure 8). Female cattle were 3.76 times more susceptible to tick infestation than male (Table 6).

Table 6. Sex wise tick infestation in cattle

Sex	Cattle examined	Infested	Non-infested	Odd ratio
Male	517	103	414	F vs. M 3.76
Female	683	330	353	

F: Female; M: Male

Tick infestation in different breeds of cattle

Among the breeds of cattle it was found that tick infestation was significantly ($p<0.05$, $\chi2= 25$, df = 2) higher in local breed (41.97%) than in NBG (37.28%) and cross breed (26.60%)(Figure 9). Local breeds were 1.21 times more susceptible to tick infestation than NBG and 1.99 times than cross breed. NBG breed were 1.64 times more susceptible to tick infestation than cross breed (Table 7).

Table 7. Tick infestation in different breeds of cattle

Breed	No. of Cattle	Infested	Non-infested	Odd ratio
Local	617	259	358	L vs C 1.99
Cross	406	108	298	N vs C 1.64
NBG	177	66	111	L vs N 1.21

L: Local; C: Cross Breed; N: North Bengal Gray

Site of infestation of tick in cattle

Ticks were collected from different body parts of the cattle such as ear, neck, groin, axilla, face, tail, flank, udder, scrotum, perianal region, ventral abdomen and base of the horn. The highest prevalence of tick infestation in ear was 72.51% followed by neck (50.34%), groin (43.41%), tail (18.01%), udder (15.01%), face (10.62%), axilla (10.16%), flank (6.00%) and scrotum (5.31%) respectively (Figure 10). A few number of tick also found in other parts of the body (16.16%) such as perianal region, ventral abdomen and base of the horn.

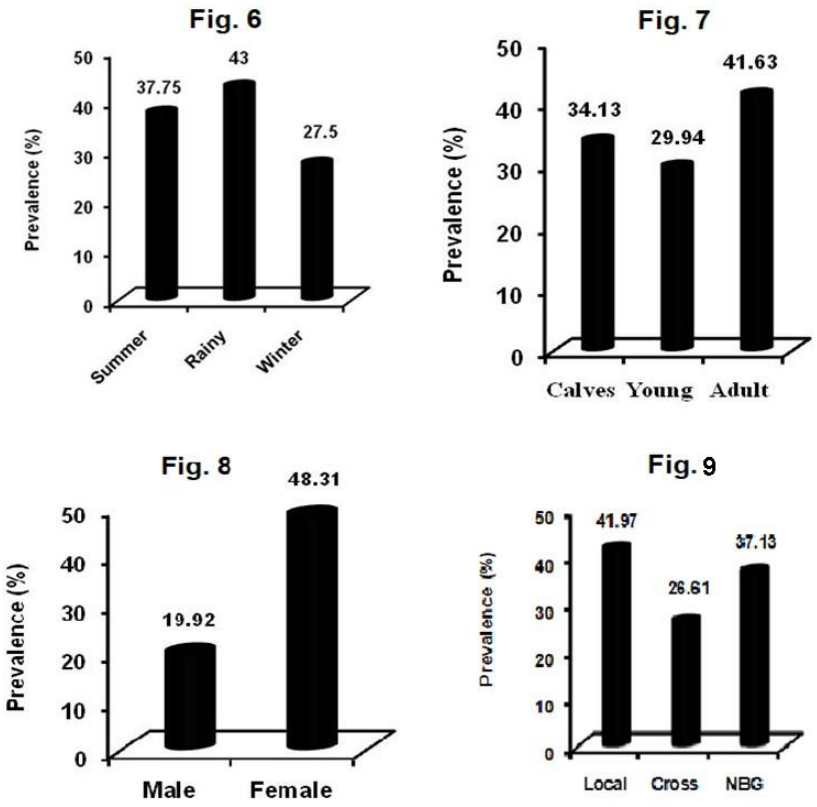

Figure 6. Seasonal variation of tick infestation in cattle; **Figure 7.** Prevalence of tick infestation in different age groups of cattle; **Figure 8.** Tick infestation status in different sex cattle; **Figure 9.** Tick infestation in different breeds of cattle

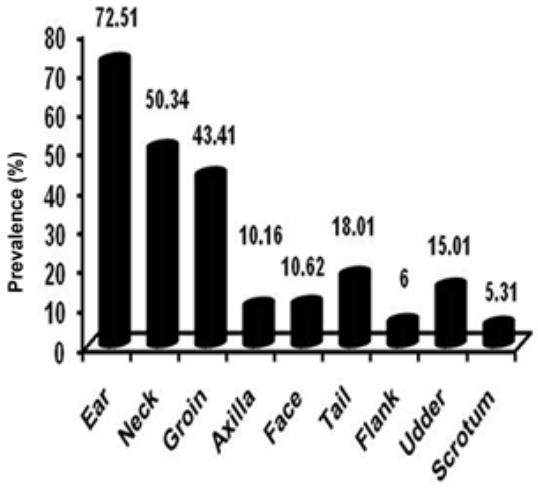

Figure 10. Site of infestation of ticks in cattle

DISCUSSION

Ticks and tick-borne diseases have potential veterinary importance especially on cattle, small ruminants, swine, birds and mammals (Eskezia and Desta, 2016). The cattle are infested with various species of ticks which may directly cause detrimental effects on productive and reproductive performances of infected individual. Indirectly, the ticks transmit highly pathogenic organisms which might cause fatal condition. The overall prevalence of tick infestation (36.08%) in cattle found in this study showed similarities and dissimilarities with the findings of the previous studies. Mostly similar infestation rate was found in Sylhet (37.67%) (Islam et al., 2015), in Chottogram (36.31%) (Kabir et al., 2011) of Bangladesh. In Balochistan of Pakistan and Uttarkahnd of India the infestation rate of ticks in cattle were reported as 35% and 37.32%, respectively (Kakar et al., 2017; Stuti et al., 2008). In contrast, dissimilarities were also observed in infestation rate in different countries such as 58.6% in India (Kaur et al., 2015), 63.4% in Nigeria (Musa et al., 2014) and 62.00% in Iran (Rahbari et al., 2007). These differences of tick infestation might be due to variation in the geographical locations, climatic conditions, rearing system and management, methods of study, selection of samples and sample size etc.

Identification of tick species in this study revealed 33.50% *Boophilus microplus*, 23.50% *Haemaphysalis bispinosa*, 17.25% *Amblyomma variegatum*, 14% *Rhipicephalus sanguineus*, 11.75% *Hyalomma anatolicum anatolicum* infestation in cattle. These findings showed similarities as well as dissimilarities with the findings of the previous studies. The infestation status of *B. microplus* in cattle reported in previous studies was varied from 18.18% to 42.40%. Variations in infestation rate of *R. sanguineus* in cattle (4.43% to 19.30%) were described by a number of researchers. Infestation status of *Haemaphysalis bispinosa* in cattle (2% to 12.63%) was reported in some previous studies. *H. ana. anatolicum* was also reported in different studies where the infestation rate was varied from 5.29% to 19.2%. A very low to high infestation rate (0.22% to 41%) of *Amblyomma variegatum* in cattle was also reported in some previous studies (Minwyelet et al., 2021; Mohamed et al., 2014; Geeta et al., 2013; Dehaghi et al., 2011; Kabir et al., 2011; Haque et al., 2011; Islam et al., 2006; Torina et al., 2006; Aydin et al., 2006; Kamal et al., 1996). It is presumed that, these differences in the specific tick infestation rate in cattle might be due to topographic influence on a site's climate, local differences in the amount of heat or water received or trapped near the surface, geographical locations, selection of samples and sample size, management and rearing system etc.

Seasonal influence on tick infestation in cattle was observed in this study which was also reported by previous studies in home and abroad. In this research, tick infestation was highest in rainy season (43%) followed by summer (37.75%) and lowest in winter (27.50%). Similarities were found in tick infestation in Sirajgonj district where prevalence was highest in rainy season (74.55%) followed by summer (67.80%) and winter (42.44%) (Hossain et al., 2016). In India, highest prevalence of tick infestation occurred during rainy season (68.08%) followed by summer (59.85 %) and winter (48.70%) (Kaur et al., 2015). In contrast, highest infestation rate of ticks was observed in summer season in cattle of Chottogram districts (41.66%) (Kabir et al., 2011) and winter season in Kurigram district (80%) (Mamun et al., 2010). Tick infestation of

84% was recorded in summer and 4.66% in winter in Balochistan of Pakistan (Kakar et al., 2017). The variation in present with previous findings may be due to differences in geographical locations, topography and composition of soil type, temperature and humidity of the research area etc. Furthermore, in rainy season, high tick infestation may be due to humidity which acts as important macroclimatic factor influencing infestation rate of ticks (Vatsya et al., 2007).

Tick infestation rate was also varied with the age of cattle. It was demonstrated that adult cattle were most susceptible to tick infestation (41.63%) followed by in calves (34.13%) and young cattle (29.94%). This finding has an agreement with other studies conducted in Sirajgonj (Hossain et al., 2016) and Gazipur of Bangladesh (Rony et al., 2010), Balochistan of Pakistan (Kakar et al., 2017), and Bahir Dar of Ethiopia (Gedilu et al., 2014). Disagreement with the findings of this study was observed with the findings of tick infestation in Chottogram district, Bangladesh (Kabir et al., 2011) and Mathura district, Uttar Pradesh, India (Patel et al., 2013]) where infection rate was much higher in calves. This may be due to lower immunity, soft and thinner skin of calves that facilitate the penetration of mouthparts of ticks for blood sucking (Sajid et al., 2008). Adult's age groups of cattle were more infested than young and calves may be due to decrease of immunity and poor body condition (Kemal et al., 2016; Manan et al., 2007). Outdoor management and long distant movement of adult cattle look for food and water might be affect more to tick infestation than younger (El-Gohary et al., 2016; Pawlos and Derese, 2013).

According to this present study, the prevalence of tick infestation was peak in female (48.31%) than male (19.92%). In Sirajgonj, the infestation rate in female was 64% and female and 52% male in Sirajgonj (Hossain et al., 2016), 59.27% female and 35.83% male in Chottogram (Kabir et al., 2011), 36% female and 32% male in Pakistan (Kakar et al., 2017), 53.1% female and 46.9% male in Egypt, (El-Gohary et al., 2016) proved higher susceptibility of female cattle to tick infestation. It is hypothesized that, female cattle are more susceptible to tick infestations due to pregnancy, post calving stress, lack of nutrition, lactation and production diseases etc. but the exact cause of it cannot be explained yet (Kabir et al., 2011). A few hormones such as prolactin and progesterone influence the infestation to female cattle (Bilkis et al., 2011; Lloyd, 1983).

This study demonstrated that, the prevalence of tick infestation was highest in local breed (41.97%) than in NBG (37.28%) and cross breed (26.60%) which was comparable to previous study in Chottogram district, where prevalence was higher in local breed (43.82%) in contrast to cross breed (24.13%) (Kabir et al., 2011). In Hawassa town of Southern Ethopia, the highest prevalence was found in local breed (74%) than exotic breeds (3.1%) (Misirach et al., 2021). In this research it was profoundly observed that, farmer has less interest to take care to local cattle than cross breed cattle. This may be due to inadequate meat and milk production in compare to cross breed cattle. But the precise cause of high prevalence of tick infestation in local cattle is still obscured. On the other hand, some researcher's study showed dissimilarities with these findings. Lower prevalence of tick infestation in local breed (27.6%) than cross breed (72.4%) was recorded in Beni Suef, Egypt (El-Gohary et al., 2016). In Balochistan of Pakistan, higher prevalence of tick infestation was recorded in crossbred (28.5%) than local breed (17.5%) (Kakar et al., 2017). According to their observation, the possible causes of lowermost tick infestation in local breed may be due to strong natural immunity but the actual cause was unknown.

Ticks were found in different predilection sites of the host body. This study detected ear as the highest tick infestation site in cattle (72.51%) and scrotum was the lowest (5.31%). A previous investigation from Chottogram district of Bangladesh recorded highest prevalence of tick in groin (48.75%) and lowest in face and neck (30.00%) region (Kabir et al., 2011). Another investigation showed 52.2% hard ticks in groin (Yakhchali and Hasanzadehzarza, 2004). It was reported that, most of the ticks usually attached to the ears and face (62%), although they were found in udder, scrotum, tail, leg and belly (Rahbari et al., 2007). These findings hypothesized that, ticks prefer warm, moist and hidden sites with smooth skin and good blood supply like ears (Muchenje et al., 2008). Attractive odors from the various predilection sites such as armpit and inner thigh also affects tick infestation (Wanzala et al., 2004).

CONCLUSION

Bangladesh is an agro-based developing country in the world in which livestock is an exigent part. Cattle are the vital component of livestock in Bangladesh. Tick infestation in cattle is one of the major threats to the livestock development in Bangladesh. Findings of this study might be helpful to develop a sustainable control strategy against ticks and tick-borne diseases in the study areas as well as throughout the country. The high prevalence of tick infestation in this area necessitate the further research to investigate the tick-borne diseases and to determine the economic losses which are the major threat to profitable cattle farming and production in subsistence farms of these areas.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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