IDENTIFICATION AND ANALYSIS OF TICKS ON BRAHMAN AND FRIESIAN-SAHIWAL CATTLE IN AN INSTITUTIONAL TEACHING FARM IN BINTULU, SARAWAK, MALAYSIA

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ABSTRACT

Ticks (Acari: Ixodidae) are highly prevalent in cattle raised in the tropics. The study aims to identify and determine the prevalence of tick infestation and associated factors in cattle from an institutional teaching farm in Bintulu, Sarawak, Malaysia. Physical examination was conducted on 84 cattle from the teaching farm and recovered ticks were identified. Factors such as breed, sex, age, and bodyweight of the cattle were recorded. The prevalence of tick infestation was 62.4%, with a total of 229 ticks isolated from 56 cattle. The tick species were identified as *Rhipicephalus microplus*. Most of the recovered ticks (60.3%) were from the ear, followed by the pin (13.5%) and elbow (6.6%). Friesian-Sahiwal breed had a higher infestation rate (26.3%; $P<0.05$) compared to the Brahman breed (12.3%). In conclusion, *R. microplus* is the only tick species found in cattle from the institutional farm and their prevalence is influenced by the age and weight of the cattle host.

Keywords: *Rhipicephalus microplus*, ticks, cattle, prevalence, associated factors

ABSTRAK

Sengkenit (Acari: Ixodidae) sangat lazim pada lembu yang diternak di kawasan tropika. Kajian ini bertujuan untuk mengenalpasti dan menentukan kelaziman serangan sengkenit pada lembu dan faktor yang berkaitan di sebuah ladang pengajaran institusi di Bintulu, Sarawak, Malaysia. Pemeriksaan fizikal telah dijalankan ke atas 84 ekor lembu dari ladang pengajaran dan sengkenit yang ditemui telah dikenalpasti. Faktor seperti baka, jantina, umur dan berat badan lembu telah direkodkan. Kelaziman serangan sengkenit adalah 62.4%, dengan sejumlah 229 ekor sengkenit dikumpulkan daripada 56 ekor lembu. Spesies sengkenit yang dikenalpasti adalah *Rhipicephalus microplus*. Kebanyakan sengkenit yang dijumpai pada telinga (60.3%), diikuti oleh bahagian pinggul (13.5%) dan siku (6.6%). Baka Friesian-Sahiwal mempunyai kadar kelaziman serangan yang lebih tinggi (26.3%; $P<0.05$) berbanding baka Brahman (12.3%). Kesimpulannya, *R. microplus* adalah satu-satunya spesies sengkenit yang dijumpai pada lembu dari ladang institusi dan kelazimannya dipengaruhi oleh umur dan berat badan perumah lembu.

Katakunci: *Rhipicephalus microplus*, sengkenit, lembu, kelaziman, faktor berkaitan

INTRODUCTION

Ticks are classified into two major families, Ixodidae (hard ticks) and Argasidae (soft tick), which the former is considered significant in both medical and veterinary importance in livestock. In Malaysia, various hard tick species such as *Rhipicephalus microplus, Haemaphysalis bispinosa*, *Haemaphysalis traubi* have been reported in livestock (Kho et al. 2015; Saad et al. 2015). Both *R. microplus* and *H. bispinosa* are the predominant tick species found in ruminants across West Malaysia (Kho et al. 2015). Other than these two species, Amblyomma, Ixodes, and Dermacentor were also molecularly documented in Malaysia for a total of 34 species identified (Ernieenor et al. 2017; Ernieenor et al. 2021). Surprisingly, due to their high adaptiveness, six species were recently added to this data bank showing the emergence and establishment of tick populations throughout Southeast Asia (Madinah et al. 2021; Petney et al. 2019). Ticks have a wide host range: from wild and domesticated hosts; and also, different types of ecological habitats, e.g: vegetation, open areas of pastures and forest ecosystems. Thus, ticks have a great epidemiological importance regarding public health due to their wide geographical distribution range with the presence of different range of hosts which can lead to the transmission of pathogenic microorganisms. Ticks may act as vectors of several diseases, such as babesiosis, anaplasmosis and theileriosis in livestock, and as reservoirs of tick-transmitted pathogens including spotted fever group rickettsiae, relapsing fever borrelia, and query fever (Jesse et al. 2020).

Heavy tick infestation may result in significant blood loss, reduced live weight gain, reduced milk yield, poor quality hides and skin, and increased susceptibility to secondary infections (Asmaa et al. 2014), while the diseases transmitted may lead to high mortality and economic losses (Eyo et al. 2014). In addition, poor husbandry practices are associated with ectoparasite infestations in cattle (Asmaa et al. 2014). Likewise, climate and management systems play important roles in the distribution and abundance of ticks in farm animals (Estrada-Peña et al. 2012; Ola-Fadunsin et al. 2018).

The specific tick species infesting livestock and their prevalence under farm conditions need to be elucidated to better understand tick-borne diseases and their potential threat to livestock. To date, no scientifically documented data on the occurrence of tick infestations in

cattle populations of Borneo Sarawak. This study presents a preliminary report on the identification and prevalence of tick infestation in cattle from a teaching farm in Universiti Putra Malaysia Bintulu Sarawak Campus (UPMKB), as well as the associated factors.

MATERIALS AND METHODS

Study Design and Study Area, and Animal Management

A cross-sectional study was conducted at Teaching Farm in UPMKB Sarawak Campus. The teaching Farm is located in Bintulu Sarawak, East Malaysia (3º12'21.87" N, 113º05'34.81" E) (Figure 1). The sampling activities were performed between September 2016 and February 2017.

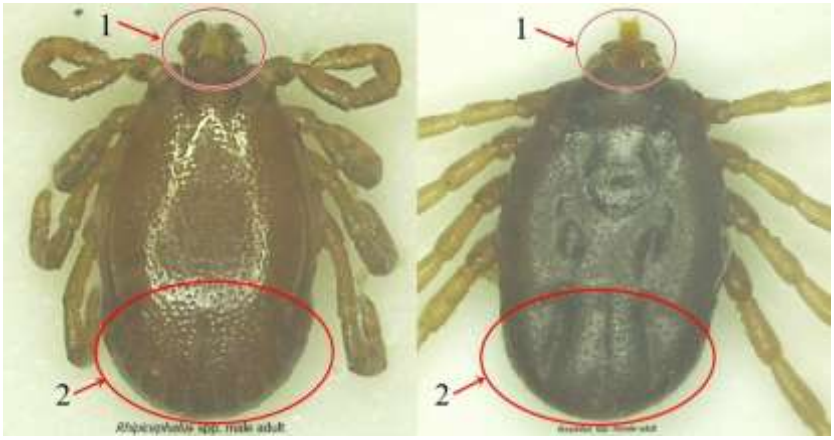

Figure 1. Tick identification: Dorsal view at 50x magnificent. From left is *Rhipicephalus microplus* male adult; right is *R. microplus* female adult. 1 is the capitulum, 2 is festoons

Brahman and Friesian-Sahiwal cattle were managed semi-intensively, provided external pasture at the University Agriculture Park (Livestock Unit) in UPMKB throughout the year and rotated between the paddocks. The animals were fed Napier grass (*Pennisetum perpureum*) and kept in different barns according to age and stage of production. All animals were treated with ivermectin to prevent and control gastrointestinal parasites.

Animal Sampling, Sample Collection, Sample Preservation and Tick Identification

A purposive sampling technique was conducted by selecting cattle from two teaching cattle farms. Sampling was performed to reflect the proportion of cattle according to breed, age, purpose, and sex. A total of 84 cattle (Brahman cattle, n = 65; Friesian-Sahiwal, n = 19) were sampled. All the Brahman cattle were kept for beef production, whereas the Friesian-Sahiwal were kept for dairy purposes. Factors such as age were categorised based on health and production records and information provided by farmers. Animals were classified into calf/young buffalo (less than 1 year), adults (1–5 years) and old (more than 5 years).

The ticks were carefully collected from the cattle's ears, elbow, pin, body, and other body parts, and preserved in universal bottles containing 70% ethanol. The samples were later dispatched to Parasitology Laboratory, UPMKB for further identification of the tick specimens. The specimens were refrigerated at 4ºC to avoid DNA fragmentation or degradation. The identification process was conducted based on morphological characteristics, including the

shape of the capitulum, scutum, eyes, festoon and hypostome, spiracle, genital groove, sure of coxa, and adanal shield (Walker et al. 2014). A digital microscope (magnification 50x to 150x) was used to screen all the enlisted activities in the identification process.

Data Analysis

All the data analyses were conducted using the Statistical Analysis System (SAS). Descriptive statistics were used to summarise the dataset and characteristics of the study population. Association between potential animal-based factors and prevalence of tick infestation was analysed using Chi-square statistics and Fisher's exact test. A P-value<0.05 was considered for any significant relationship.

RESULTS

Descriptive Results, Prevalence and Distribution of Tick Infestation

Most of the cattle were Brahman breed (65/84; 77.3%) compared to Friesian-Sahiwal (19/84; 32.7%). The proportion of female to male cattle were 58% and 42%, respectively. A total of 229 ticks were isolated from 84 cattle, corresponding to a prevalence of 15.5% (Table 1). Friesian-Sahiwal cattle had a higher infestation rate (26.3%) compared to the Brahman cattle (12.3%) (Table 1).

Table 1. Total number of animals (n), prevalence (%) and distribution of tick infestation in Brahman transit, Brahman dan Friesian Sahiwal in Teaching Farm in UPMKB Bintulu

Breed	Total Number of Animals	Infestation n (%)			
		Positive	Negative	Prevalence	Distribution of *R. microplus*
Brahman transit	49	6 (12.2)	0 (0.0)	12.2	
Brahman	16	2 (12.5)	14 (87.5)	12.5	8 (12.3)
Friesian Sahiwal	19	5 (26.3)	14 (73.7)	26.3	5 (26.3)
Total	84	13 (15.5)	28 (33.3)	15.5	13 (15.5)

The recovered ticks were identified as *Rhipicephalus microplus* as shown in Figure 1-2. The majority of *R. microplus* (130/229; 56.8%) were collected from Brahman cattle. Both nymph and adult stages were isolated from the positive cattle (Table 2 & Figure 3). Lower numbers of *R. microplus* in nymph stages (0-0.9%) were collected when compared to those from unfed female adults (23.6%). Meanwhile, the lowest amount of tick stages in Friesian-Sahiwal cattle were from fully engorged females (1.3%), whereas the highest number of stages were from female unfed adults (14.4%) compared to the results in Brahman cattle (Figure 3). Most of the ticks (65%) were collected from the ear, with almost equal proportions in Brahman (30.6%) and Friesian-Sahiwal breed (29.7%). Other major predilection sites for *R. microplus* were the pin (13.5%), elbow (6.6%), fore udder (5.2%), rear udder (4.4%), horn (3.9%), and brisket (3.5%) **(**Figure 4**).** The male to female ratio of the adult *R. microplus* was 1:3.5 (44 vs. 155; 19.2% vs. 67.6%) **(**data not shown).

Table 2. Distribution of ticks' stages in Brahman (n=65) dan Friesian Sahiwal (n=19) in Teaching Farm in UPMKB Bintulu

Breed	***Rhipicephalus microplus* (%)**						
	1	**2**	**3**	**4**	**5**	**6**	**Total**
Brahman	2 (0.9)	0 (0.0)	28 (12.2)	54 (23.6)	30 (13.1)	16 (7.0)	130 (56.8)
Friesian Sahiwal	18 (7.9)	10 (4.4)	16 (7.0)	33 (14.4)	19 (8.3)	3 (1.3)	99 (43.2)
Total (%)	20 (8.7)	10 (4.4)	44 (19.2)	87 (38.0)	49 (21.4)	19 (8.3)	229 (100.0)

Stage of ticks = 1: Nymph; 2: Fully engorged nymph; 3: Male unfed adult; 4: Female unfed adult; 5: Female partially engorged; 6: Female fully engorged.

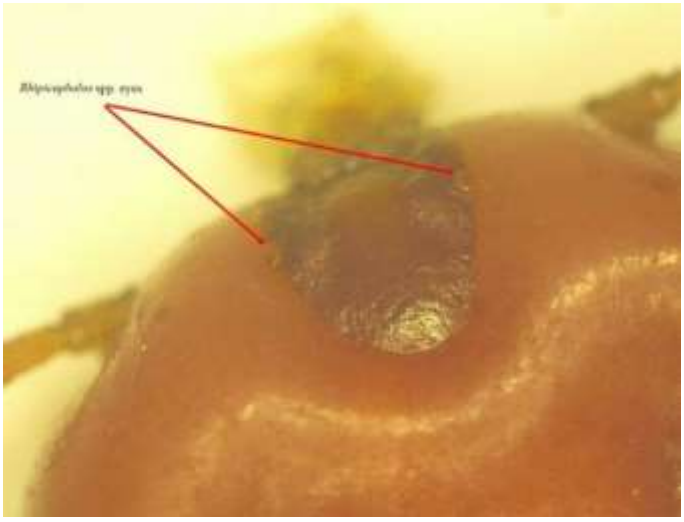

Figure 2. Tick identification: Dorsal view at 150x magnificent (Side notes: The tick will fall into genera *R. microplus* if the eyes present together with short mouthparts and palpi not projecting laterally (Walker et al. 2014)

Figure 3. Dorsal view at 20x magnificent. Tick stages from left; nymph, male adult, female adult and female fully engorged

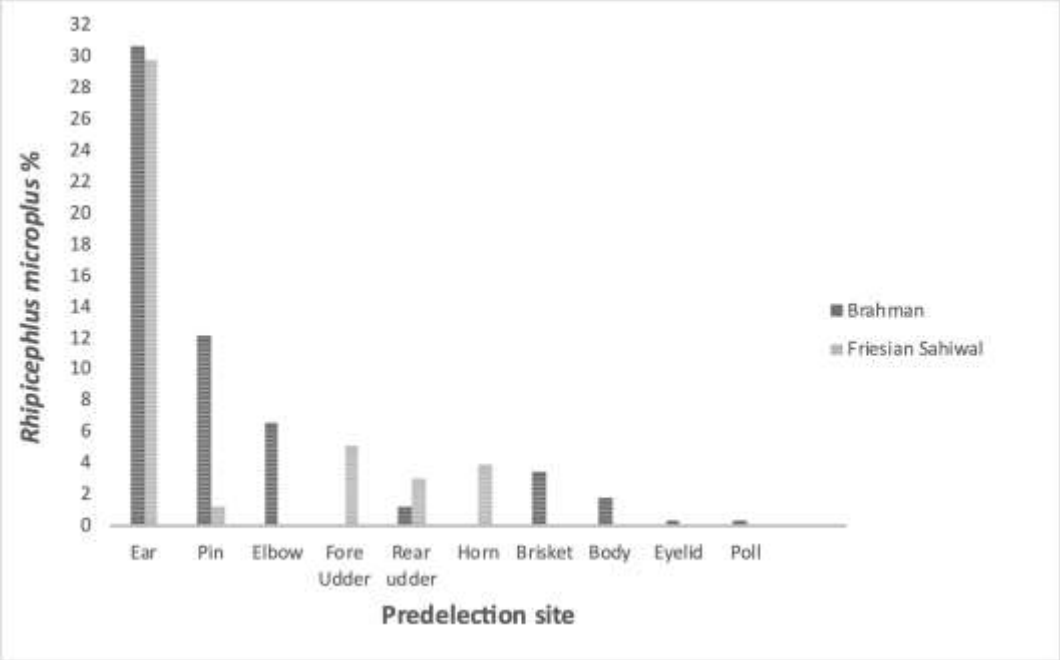

Figure 4. Percentage of tick *Rhipicephalus microplus* (%) on different predilection site

Factors Associated with Tick Infestation

Brahman cattle (*P<0.05*) had a higher prevalence compared to Friesian-Sahiwal cattle (Table 3). No significant association was detected between tick infestation and sex, age, and body weight.

Table 3. Distribution of tick infestation associated with breed, age, sex and body weight

Variable	**Level of Variable**	**Count Animal**	Total	***P*-Value**
Cattle breed	Brahman =1	1=65/84	77.4%	0.01
	Friesian Sahiwal=2	2=19/84	22.6%	
Examined cattle	Positive =1	1=56/84	66.7%	
	Negative =2	2=28/84	33.3%	
Sex	Missing response=0	0=43/56	76.8%	
	Male=1	1=7/56	12.5%	
	Female=2	2=6/56	10.7%	
Age	Missing response=0	0=49/56	87.5%	
	1 year = 1	1=2/56	3.6%	
	2 - 3 year = 2	2=1/56	1.8%	
	> 3 year = 3	3=4/56	7.1%	
Body weight	Missing response=0	0=49/56	87.5%	
	≤100 = 1	1=0/56	0.0%	
	100-200 = 2	2=2/56	3.6%	
	200-300 = 3	3=4/56	7.1%	
	300-400 = 4	4=0/56	0.0%	
	400-500 = 5	5=0/56	0.0%	
	≥500 = 6	6=1/56	1.8%	

DISCUSSION

The prevalence of tick infestation in the studied population was 15.5%, and all the tick species were identified as *Rhipicephalus microplus.* These results are consistent with previous studies reporting the wide distribution of *R. microplus* in Southeast Asia (Low et al. 2016; Sahara et al. 2019) and other Asian countries (Eyo et al. 2014; Nath et al. 2015; Nejash, 2016). *R. microplus* was also identified as the most prevalent tick found in different cattle breeds (Eyo et al. 2014; Pothmann et al. 2016). Climatic conditions, geographical locations, and animal husbandry practices might contribute to the high distribution and abundance of tick species infesting domestic cattle in the present farm (Eyo et al. 2014; Regasa et al. 2015).

The studied farm had two cattle breeds (Brahman and Friesian-Sahiwal), divided into three groups (Brahman transit, Brahman UPMKB and Friesian-Sahiwal), and kept in different pens. The present results revealed that the Brahman transit cattle were all positive for tick infestation which confirms the higher incidence of tick infestation levels for this breed in comparison to Friesian-Sahiwal cattle. The response to tick infestations are depending on specific behaviours such as cattle movements and grooming reduce the resistance to ectoparasites (Ikpeze et al. 2011). The response to tick infestations depends on specific behaviour such as cattle movement and grooming, reducing the resistance to ectoparasites (Ikpeze et al. 2011). Thus, screening and quarantining of any new stock to the herd is recommended to control the prevalence of infectious disease.

Even though higher tick infestation levels were found in Brahman compared to Friesian-Sahiwal cattle, tick infestation per positive cattle was higher in the latter breed. This is because *Bos taurus* cattle such as Friesian-Sahiwal are less resistant to tick infestation than *Bos indicus* (Nejash 2016). There have also been other studies showing that Brahman × LID and the KK × Yellow China breeds were also at higher risk of infection with *A. marginale* in comparison to indigenous breeds (Ola-Fadunsin et al. 2018). Therefore, the capacity to effectively control tick burden differs between cattle breeds.

The most abundant tick infestation occurred in the ear area, 60.3% of the total tick distribution. Ears were among the most common predilection site for tick infestation (Asmaa et al. 2014). Besides, the least number of ticks were found on the eyelid and poll, with less than 1% of the tick population in both areas. Hosts' skin thickness is a vital factor influencing the body parts invaded by ticks (Huruma et al. 2015). Ticks prefer to infest on hosts' body parts with less skin thickness for easy penetration of vascular lining during feeding, offering better protection and favourable conditions for their development (Huruma et al. 2015). These factors might explain the abundance of recovered ticks from the ears compared to other exposed body parts. Meanwhile, *R. microplus* was the single tick specie recovered from the studied cattle population. Aside from the ears, they were found on the belly, dewlap, shoulders, and flanks which agreed with previous findings (Walker et al. 2014). Other species; *R. decoloratus* were found on the dewlap and neck; *R. evertsi evertsi* occurs mostly under the tail and ventral body parts; and *Amblyomma variegatum* recedes on ventral body parts (Regasa et al. 2015).

The ratio of female and male adult ticks of *R. microplus* (1:3.5) was wide in this study. According to Tadesse et al. (2012), the fully engorged female drops off from the host to lay their eggs, whereas the male will remain attached to the host. However, the present study's higher proportion of female than male ticks may be due to feeding activity. Female ticks stay longer on their host to be fully fed and to mate with the available male counterparts. Both cattle breeds had higher proportions of fully fed engorged female ticks, which might be due to

continuous exposure to ectoparasites. The current immune status may also contribute to high levels of these tick stages in the cattle population (Nath et al. 2015).

Male cattle had a higher tick infestation prevalence than female cattle in this study, which aligns with Eyo et al. (2014) and Teshome et al. (2016). The health status and physical condition of female cattle during pregnancy and lactation may not be favourable for ticks; hence, their preference for male cattle (Eyo et al. 2014). In addition, most of the male cattle in the studied farm were kept outdoors and left to graze, which may heighten the exposure to tick infestation.

The distribution and prevalence of tick infestation were higher in adult cattle, aged more than three years compared to young cattle of one-year-old, which is consistent with Teshome et al. (2016). The resistance of animals to tick infestation increases with age, and the animals become more adaptive compared to naïve and younger animals (Manan et al. 2007). Furthermore, cattle with less than 300 kg bodyweight had a higher prevalence of tick infestation than those with >300 kg bodyweight. Cows with low body weight might be less preferred by ticks due to insufficient hosts' nutrient reserve to support their growth (Eyo et al. 2014).

CONCLUSION

Conclusively, this preliminary report revealed a high prevalence of tick infestation in cattle from teaching farms in UPMKB. The hard tick *R. microplus* was the main tick specie recovered from the cattle positive for tick infestation, and only breed demonstrated a significant association with tick burden. These factors may be considered for preventive strategies against the ectoparasites in the studied farm.

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AUTHORS DECLARATIONS

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Conflict of Interest
The authors declare that they have no conflict of interest.

Ethics Declarations
No ethical issue required for this research.

Data Availability Statement
My manuscript has no associated data.

Authors' contributions
Conceptualization and original draft preparation, NHI, AMHK and J.K.; Supervision, J.K.; S.S.S.H. and SH; design and interpretation of the data, MBS, SAA, MAM and M.N.H., review

and editing; MM, and BTP. All authors have read and agreed to the published version of the manuscript.

REFERENCES

Asmaa, N.M., ElBably, M.A. & Shokier, K.A. 2014. Studies on prevalence, risk indicators and control options for tick infestation in ruminants. *Beni-Suef University Journal of Basic and Applied Sciences* 3: 68-73.

Ernieenor, F.C.L., Ernna, G. & Mariana, A. 2017. Phenotypic and genotypic identification of hard ticks of the genus *Haemaphysalis* (Acari: Ixodidae) in Peninsular Malaysia. *Experimental and Applied Acarology* 71(4): 387-400.

Ernieenor, F.C.L., Ai Takano., Ernna, G. & Mariana, A. 2021. Integrated henotypic and genotypic approach for characterization of local questing hard tick, *Dermacentor compactus* (Acari: Ixodidae). *Serangga* 26(3): 13-28.

Estrada-Peña, A., Ayllón, N. & De La Fuente, J. 2012. Impact of climate trends on tick-borne pathogen transmission. *Frontiers in Physiology* 3: 64.

Eyo, J.E., Ekeh, F.N., Ivoke, N., Atama, C.I., Onah, I.E., Ezenwaji, N.E. & Ikele, C.B. 2014. Survey of tick infestation of cattle at four selected grazing sites in the tropics. *Global Veterinaria* 124: 479-486.

Huruma, G., Abdurhaman, M., Gebre, S. & Deresa, B. 2015. Identification of bovine tick species and their prevalence in and around Sebeta Town, Ethiopia. *Journal of Parasitology and Vector Biology* 7: 1-8.

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* 9: 1-8.

Jesse, F.F.A., Paul, B.T., Hashi, H.A., Chung, E.L.T., Abdurrahim, N.A. & Lila, M.A.M. 2020. Seroprevalence and risk factors of Q fever in small ruminant flocks in selected States of Peninsular Malaysia. *Thai Journal of Veterinary Medicine* 50: 511-517.

Kho, K.L., Koh, F.X., Jaafar, T., Nizam, Q.N. & Tay, S.T. 2015. Prevalence and molecular heterogeneity of *Bartonella bovis* in cattle and *Haemaphysalis bispinosa* ticks in Peninsular Malaysia. *BMC Veterinary Research* 11: 1-9.

Low, V.L., Tay, S.T., Kho, K.L., Koh, F.X., Tan, T.K., Lim, Y.A., Ong, B.L., Panchadcharam, C., Norma-Rashid, Y. & Sofian-Azirun, M. 2016. Molecular characterisation of the tick *Rhipicephalus microplus* in Malaysia: New insights into the cryptic diversity and distinct genetic assemblages throughout the world. *Parasites and Vectors* 8: 341.

Madinah, A., Nur Akifah, M.J., Raja Nur Atiqah, R.A., Mariana, A. & Abdullah, M.J. 2021. Ectoparasites fauna of rodents and scandents at different habitats of Sarawak, Malaysia. *Serangga* 26(2): 26-46.

Manan, A., Khan, Z. & Ahmad, B. 2007. Prevalence and identification of ixodid tick genera in frontier region Peshawar. *Journal of Agricultural and Biological Science* 2: 21-25.

Nath, T.C., Ilyas, N., Datta, R., Deb, L.C., Debnath, N. & Hossain, M. 2015. Ectoparasitic infestation of cattle in Brahmanpara Upazilla of Comilla, Bangladesh. *Journal of Biological Chemistry and Research* 32: 215-221.

Nejash, A. 2016. Review of important cattle tick and its control in Ethiopia. *OALib* 3: 1-11.

Ola-Fadunsin, S.D., Gimba, F.I., Abdullah, D.A., Sharma, R.S., Abdullah, F.J. & Sani, R.A. 2018. Epidemiology and risk factors associated with *Anaplasma marginale* infection of cattle in Peninsular Malaysia. *Parasitology International* 67: 659-65.

Petney, T.N., Boulanger, N., Saijuntha, W., Chitimia-Dobler, L., Pfeffer, M., Eamudomkarn, C., Andrews, R.H., Ahamad, M., Putthasorn, N., Muders, S.V., Petney, D.A. & Robbins, R.G. 2019. Ticks (Argasidae: Ixodidae) and tick-borne diseases of continental Southeast Asia. *Zootaxa* 4558(1): 1–89.

Pothmann, D., Poppert, S., Rakotozandrindrainy, R., Hogan, B., Mastropaolo, M., Thiel, C. & Silaghi, C. 2016. Prevalence and genetic characterization of *Anaplasma marginale* in zebu cattle (*Bos indicus*) and their ticks (*Amblyomma variegatum, Rhipicephalus microplus*) from Madagascar. *Ticks and Tick-borne Diseases* 7: 1116-1123.

Regasa, T.D., KebedeTsegay, A. & Waktole, H. 2015. Prevalence of major ectoparasites of calves and associated risk factors in and around Bishoftu town. *African Journal of Agricultural Research* 10: 1127-1135.

Saad, K., Hadi, N.I., Nadarasan, R., Steven, V., Hashim, N.A. & Rahman, W.A. 2015. Endo- and ectoparasite infections in two cattle farms located in Kuala Terengganu, Peninsular Malaysia. *Asian Journal of Agriculture and Food Sciences* 34: 667-674.

Sahara, A., Nugraheni, Y.R., Patra, G., Prastowo, J. & Priyowidodo, D. 2019. Ticks (Acari: Ixodidae) infestation on cattle in various regions in Indonesia. *Veterinary World* 12: 1755.

Tadesse, F., Abadfaji, G., Girma, S. & Jibat, T. 2012. Identification of tick species and their preferred site on cattle body in and around Mizan Teferi, Southwestern Ethiopia. *Journal of Veterinary Medicine and Animal Health* 4: 1-5.

Teshome, T., Deneke, Y. & Ibrahim, N. 2016. Prevalence and species composition of ticks infesting cattle in and around Bishoftu Town, Oromia Region, Ethiopia. *Global Veterinaria 16*: 238-246.

Walker, A.R., Bouattour, A., Camicas, J.L., Estrada-Pena, A., Horak, I.G., Latif, A.A., Pegram, R.G. & Preston, P.M. 2014. Biology of ticks and methods of identification. Ticks of domestic animals in Africa: A guide to identification of species. *Edinburgh, Scotland, Biosciences Reports* 21-27.