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A study on epidemiology of hard tick (Ixodidae) in sheep in Sulaimani governorate - Iraq

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Abstract

This study was carried out for the period from the beginning March 2009 till end of February 2010 in three zones I, II, and III (Mountainous, Semi-mountainous and foothills and plane) regions, respectively in Sulaimani governorate for distribution of ticks (Ixodidae) that infested sheep. The prevalence rate of infested sheep in all zones was 298 (11.8%) in Sulaimani governorate, and the prevalence rate of infestation in zone-I was 85 (10.1%), in zone-II 94 (11.1%), and in zone-III 119 (14.3%). The rate of infestation was high in March, April, May and July in all zones; no infestation was observed in zone-I and zone-II in November to February, but was observed in zone-III. *Hyalomma anatolicum anatolicum, H. marginatum, Rhipicephalus turanicus* and *R. sanguineus* were found and identified, two species were more predominant among sheep *H. a. anatolicum* in zone-III (Garmian region) 353 (70.0%) and *R. turanicus* in zone-I (Pishder region) 177 (59.4%), and *H. a. anatolicum* was found through March 61 (75.3%), April 89 (69%), May 92 (68.7%), and June 50 (74.6%) in zone-III. *Hyalomma a. anatolicum* and *R. turanicus* were found through March 22 (53.6%), 12 (29.3%): April 36 (41.4%), 38 (43.7%): May 46 (46.9%), 33 (33.7%), and June 41 (53.2%), 25 (32.5%) in zone-II respectively. *H. marginatum* and *R. sanguineus* were found in April 18 (14%), 11 (8.5%), and May 16 (11.9%), 13 (9.7%) in zone-III respectively, while *R. turanicus* was highly distributed in April 48 (71.6%) and May 57 (65.5%) in zone-I. According to linear model of the percentage of infested sheep in any zone by number of ticks was recognized and it was high in zone-III [3.1 + 0.23 Number of ticks (X)]. The ratio of male to female tick infested sheep was 1: 2 during the study. The site of attachment of ticks was observed; the highest number was noticed on the ears 492 (42.0%) and under tail 208 (17.7%).

Keywords: Hard ticks; Ixodidae; Sheep.
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دراسة وبائية القراد الصلب في الاغنام فى محافظة السليمانية-العراق

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الخلاصة

أجريت هذة الدراسة للفترة من أذار ٢٠٠٩ لغاية شباط ٢٠١٠ في ثلاثة مناطق (الجبليه شبه جبليه الهضاب والمنبسط ١، ٢ و٣) مختلفة في محافظة السليمانية لبيان انتشار القراد (Ixodidae) في الأغنام المصابة. أن نسبة أنتشار الأصابة في الاغنام في المناطق الثلاثة كان ٢٩٨ (١١,٨%) في محافظة السليمانية، وكانت نسبة الاصابة في المنطقة الاولى (منطقة بشدر) ٨٥ (١٠,١%) وفي المنطقة الثانية (مركز السليمانية) ٩٤ (١١,١%) وفي المنطقة الثالثة (منطقة كرميان) ١١٩ (١٤,٣%). نسبة الاصابة كانت عاليه في الأشهر، أذار و نيسان ومايس و تموز في جميع المناطق. بينما لم تكن هناك اصابة بين شهري تشرين الثاني وشباط، ولكن ظهر الأصابة في المنطقة الثالثة. تم تشخيص جنسين *Hyalomma* و *Rhipicephalus* واربعة انواع من القراد *Hyalomma anatolicum anatolicum, Hyalomma marginatum, Rhipicephalus turanicus, Rhipicephalus sanguineus*. كانت هناك نوعين أكثر شيوعا" ضمن الأغنام المصابة وهما *Hyalomma anatolicum anatolicum* في المنطقة الثالثة (منطقة كرميان) ٣٥٣ (٧٠ %) و *Rhipicephalus turanicus* في المنطقة الأولى (بشدر) ١٧٧ (٥٩,٤%). وجدت النوع *H. a anatolicum* في شهر أذار ٦١ (٧٥,٣%)، ونيسان ٨٩ (٦٩%) ومايس ٩٢ (٦٨,٧%)

وتموز ٥٠ (٧٤,٦%) بالتعاقب في المنطقة الثالثة (كرميان). وجدت ايضا" بان *H. marginatum* و *R. sanguineus* في شهر نيسان ١٨ (٤%) و ١١ (٨,٥%) وفي شهر مايس ١٦ (١١,٩%) و ١٣ (٩,٧%) بالتعاقب في المنطقة الثانية. بينما *R. turanicus* كانت عالية الأنتشار في نيسان ٤٨ (٧١,٦%) وفي مايس ٥٧ (٦٥,٥%) في المنطقة الأولى. بطريقة المعادلة الخطية، النسبة المئوية اللأغنام المصابة في أي منطقة من المناطق الثلاثة مقارنة" مع عدد القراد كانت مميزة وكان عاليا" في المنطقة الثالثة [٣,١ + ٠,٢٣ عدد القراد (X)]. ولوحظ بان نسبة الأناث الى الذكور كان ١:٢. تم دراسة موقع وجود القراد والتصاقة بأ جسا م الأغنام، و اعلى نسبة للقراد كانت في الأذن ٤٩٢ (٤٢%) وتحت الذيل ٢٠٨ (١٧,٧%).

Introduction

There are two well established families of tick, the Ixodidae (hard tick), and Argasidae (soft tick), both are important vectors of disease-causing agents to human and animals throughout the world (1). Tick is obligatory blood sucking arachnid arthropods; infesting mammals, birds, reptiles and amphibian. They act as vectors of diseases, causing anemia, dermatitis, paralysis, otoacariasis as well as loss of production (2). These parasites generate direct effect in cattle on terms of milk production and gain weight reduction (3). In Ixodidae, the hard ticks, there are several genera and species. Those of veterinary importance are in the genera Boophilus, Rhipicephalus, Amblyomma, Haemaphysalis, Hyalomma, Dermacentor and Ixodes (4).

Some species of hard ticks are important vector of *Nairovirus* (Crimean Congo Hemorrhagic Fever), theileriosis, babesiosis and anplasmosis (5). Usually associated with tick of genera *Hyalomma* spp. and widely prevalent within those handling field tick, also infestation with ticks has a variety of direct and indirect effects on their host through blood loss, skin inflammation (Pruritus), hair and wool loss, toxic and allergic reaction (6).

The present study was planned to show the prevalence of hard ticks in Sulaimania governorate.

Material and methods

A survey study was carried out to show the distribution of ticks in Sulaimani governorate. Sulaimani governorate is located at north east of Iraq. The international border with Iran represents the eastern boundary of the governorate. It is bounded in north and north-west by Erbil governorate, west by Kirkuk governorate and Salahaddin governorate, south and southwest by Diala. Sulaimani governorate was divided in to three different zones, depended on topography and climate factors for study on the distribution of Ixodidae. The three zones were; Zone I, Mountainous areas; Zone II, Semi-mountainous areas and Zone III, foothills and plane areas**.**

Tick collection and identification

Ticks were collected from 2025 local breed sheep from various flock, in three different zones (Zone-I: 840, Zone-II: 850, and Zone-III: 835) through periods from the beginning of March 2009 till the end of February 2010 (Table 1). Ticks were counted and identified, based on morphological features according to (7 and 8) using a dissecting microscope (Dissecting microscope, Motic-Education, China.), magnifying-hand lens and the binocular microscope (Altay, Biovision-103B, Chin).

A total number of 1171 ticks were collected form the three different zones (Zone-I: 298, Zone-II: 369, and Zone-III: 504) as shown in (Table 1).

Table (1): Number of sheep examined and tick collected from sheep in different zones.

Zone	Location	N0. of sheep examined	NO. of tick collected
Zone-I	Peshder region (Qaladaza- Sangasar-Rania-Betwata-Bingird)	840	298
Zone-II	Sulaimani region (Qaradakh-Mawat-Penjwen-Halabja-Chamchamal, Bazyan)	850	369
Zone-III	Garmian region (Kalar-Kifri- Maydan-Darbandekhan, Sangaw)	835	504
Total		2525	1171

Statistical analysis: Statistical analysis was conducted using SPSS from windows (Version 7). Chi-square and t-test were done to find significant differences between zones, seasons, species and sex (9).

Results

Tick speices and distribution

In this study two genera of hard ticks, *Hyalomma* and *Rhipicephalus* were observed and for each genus, two species (*Hyalomma anatolicum anatolicum, H. marginatum*) and (*R. turanicus, R. sanguineus*) were identified according to morphological features.

Table (2) shows four species of ticks which were identified from the genera Hyalomma (*H. a anatolicum*, *H. marginatum*), the highest number and percentage species were *H. a anatolicum* 608 (51.9%), *H. marginatum* 122 (10.4%), and genera Rhipicephalus, *R. sanguineus* 90 (7.7%) and *R. turanicus* 351 (30%) during the study year.

Table (2): Number and percentage of different tick species identified in 3 zones in Suliamani governorate.

Zones	Genus: Rhipicephalus		Genus: Hyalomma		Total No. Ticks
	No. & (%) *R. sanguineus*	No. &(%) *R. turanicus'*	No. & (%) *H. a anatolicum*	No. & (%) *H. marginatum*	
Zone- 1	23 7.7	177 59.4	64 21.5	34 11.4	298
Zone- II	20 5.4	124 33.6	191 51.8	34 9.2	369
Zone-III	47 9.3	50 10.0	353 70.0	54 10.7	504
Total	90 7.7	351 30.0	608 51.9	122 10.4	1171

The data in table (3) show that the distribution of tick species during different months of the study according to Chi square test showed fluctuation in the occurrences. The number of *H anatolicum anatolicum* was highly distributed in March, April, May, and June 61 (75.3%), 89 (69%), 92 (68.7%), and 50 (74.6%), respectively in zone-III and *Rhipicephalus sanguineus* was highly distributed in April, May, and June 11 (8.5%), 13 (9.7%), and 10 (14.9%) respectively in zone-III in comparison with other zones, while the number of *Hyalomma marginatum* was highly distributed in April and May 18 (14%) and 16 (11.9%) in zone-III comparing to other zones and the number of *Rhipicephalus turanicus* was highly distributed in zone-I in March, April and May 23 (71.8%), 48 (71.6%), and 57 (65.5%) respectively.

The distribution of ticks according to seasons (figure 1), showed that it was highest in spring, followed by summer, then the number of ticks was decreased in both autumn and winter seasons.

The data in table (4) show the mean value (Mean ± SE) of distribution of different species of tick: *H. anatolicum anatolicum* was highest in zone-III 35.3 ± 18.4 followed by zone-II 23.9 ± 9.1 and zone-I 8 ± 2.5 respectively, while in *Hyalomma marginatum* the difference did not vary significantly among the zones, *Rhipicephalus sanguineus* was highest in zone-III 6.7 ± 2.8 in comparism to zone-I, 2.9 ± 1.2 and 2.9 ± 1.1 in zone-II, while the species *Rhipicephalus turanicus* distribution was highest 29.5 ± 2.9 in zone-I followed by zone-II 15.5 ± 7.6 and zone-III 6.3 ± 3.5.

The results in table (5) show the distribution of tick sexes. It was found the number of infested female tick was greater than the male and the ratio of male to female was 1:2.4.

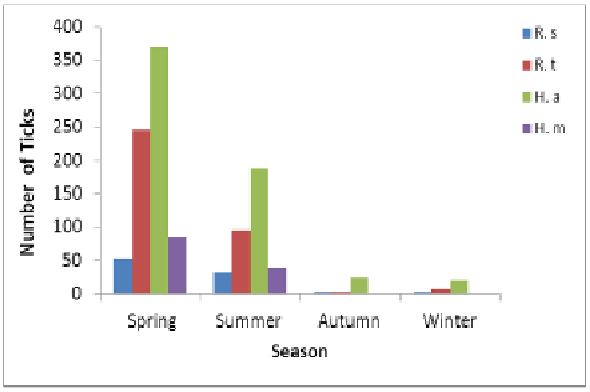


Figure (1): Distribution of tick according to seasons.

Table (6) show that the total number of adult tick was mostly engorged female for both genera 554 (47.3%) followed by non-engorged females 263 (22.5%) and adult male 354 (30.2%). *H. anatolicum anatolicum* gave the highest number of engorged females 319 (57.6%) and male 177 (50%), followed by *Rhipicephalus turanicus* 147 (26.5%) engorged females and 110 (31.1%) adult males, while *H. marginatum* females were 49 (8.9%) and males 40 (11.3%) and *R. sanguineus* females were 39 (7.0%) and males was 27 (7.6%), respectively. No nymph and larvae were found.

The results in table (7) show the sites of attacks of the tick on the body of infested sheep. The highest number 492 (42.0%) of ticks was on ear, followed by under tail 208 (17.7%), udder 139 (11.9%), between thighs 112 (9.6%), under axilla 105 (9.0%) and testes 95 (8.1%).. The lowest number was on eyelid 20 (1.7%).

Table (3): Distribution of tick species according to months in different zones.

Months	Zone-I				Zone-II				Zone-III			
	R. spp (No.& %)		*H. spp* (No.& %)		*R. spp* (No.& %)		*H. spp* (No.& %)		*R..spp* (No.& %)		*H. spp* (No.& %)	
	*R. s**	*R. t**	*H a.a**	*H m**	*R. s*	*R. t*	*H a.a*	*H. m*	*R. s*	*R. t*	*H. a*	*H. m*
March	2 6.3	23 71.8	5 15.6	2 6.3	3 7.3	12 29.3	22 53.6	4 9.8	4 4.9	10 12.4	61 75.3	6 7.4
April	3 4.5	48 71.6	9 13.4	7 10.5	6 6.9	38 43.7	36 41.4	7 8	11 8.5	11 8.5	89 69	18 14
May	6 6.9	57 65.5	15 17.2	9 10.4	4 4.1	33 33.7	46 46.9	15 15.3	13 9.7	13 9.7	92 68.7	16 11.9
Spring//Total	11	128	29	18	13	83	104	26	28	34	242	40
June	7 12.7	24 43.6	15 27.3	9 16.4	4 5.2	25 32.5	41 53.2	7 9.1	10 14.9	3 4.5	50 74.6	4 6
July	2 6.9	16 55.2	5 17.2	6 20.7	1 2.2	12 26	32 69.6	1 2.2	5 15.6	3 9.4	18 56.3	6 18.7
August	1 6.2	9 56.3	5 31.3	1 6.2	1 9.1	2 18.2	8 72.8	0 0.0	1 4.8	2 9.5	14 66.7	4 19
Summer/Total	10	49	25	16	6	39	81	8	16	8	82	14
September	1 11.1	0	8 88.9	0	1 16.7	1 16.7	4 66.6	0	0	1 20	4 80	0
October	1 33.3	0	2 66.7	0	0	1 33.3	2 66.7	0	0	0	3 100	0
November	0	0	0	0	0	0	0	0	0	0	1 100	0
Autumn/Total	2	0	10	0	1	2	6	0	0	1	8	0
December	0	0	0	0	0	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0	0	3 9.7	7 22.6	21 67.7	0
Winter/Total	0	0	0	0	0	0	0	0	3	7	21	0
Total Number	23	177	64	34	20	124	191	34	47	50	353	54
Total ticks	298				369				504			
Total Number	1171											
χ^2cal P < 0.01	281.6 **											

*R. s. = Rhipicephalus sanguineus; R. t. = Rhipicephalus turanicus; H. a. a. = Hyalomma anatolicum anatolicum; H. m. = Hyalomma marginatum. *<0.05 **<0.01.*

Table (4): Distribution of tick species in different zones in Sulaimania governorate.

Zone	Tick species (Mean ± SE)			
	H. anatolicum. Anatolicum	*H. marginatum*	*R. sanguinus*	*R.turanicus*
I	8.0 ± 2.5 b	5.6± 2.1 a	2.9± 1.2 b	29.5±2.9 a
II	23.9± 9.1 ab	6.8± 3.2 a	2.9± 1.1 b	15.5±7.6 ab
III	35.3± 18.4 a	9.0± 4.3 a	6.7± 2.8 a	6.3± 3.5 b

Numbers with the same letter within a column are not differ significantly from each other according to Duncan's multiple range tests ($P \leq 0.05$).

The results in table (8) show that out of the 2525 sheep, 298 (11.8%) were infested with tick in all three zones, and the prevalence rate of infested sheep in zone-I, zone-II, and zone-III were (10.1%, 11.1%, and 14.3%), respectively. Although the number and rate of tick infestation of sheep was highest in zone-III than that of the zone-I and II, but

statistically there was not significant difference between zones.

The rate of infestation was higher in May 22.0, 23.3 and 36.0% in the three zones 1,11, 111 respectively than other months of the study, and there was no infested sheep observed in zone-I and zone-II from November to February, while in zone-III the rate of infestation was 2.0, 0%, 0.0 and 15.0%, in December, January and February respectively.

The data in table (9) show that, the distribution of tick's species were not differed significantly among the zone-I, zone-II, and zone-III (298, 396, and 504), respectively. The higher number of ticks collected from sheep in April, May and June 32, 67, and 87 in zone-I, 41, 87, and 98 in zone-II and 81, 129, and 134 in zone-III respectively, but the number was low in July till October 29, 16, 9, and 3 in zone-I, 46, 11, 6, and 3 in zone-II and 32, 21, 5, and 3 in zone-III respectively, and no tick was collected in November till February in zone-I and zone-II, except in zone III only 31 ticks were collected in February.

The percentage of infested sheep in any zone by number of ticks was recognized from the linear model in (Figure 4; A, B and C). There were difference infestation rates in different zones, the highest infestation was recorded in zone III which was (3.1) followed by zone II which was (2.3) and the lowest rate (2.0) recorded in zone I. The linear model in zone-I, II and III showed that the $\mathbf{r^2}$ were highly significant, and the number of ticks was an indicator for estimation of the infested percentage. Hence each tick infestation was increased in rate 0.25 in zone-I, and in the zone-III, each tick showed that the increasing of infested rate by 0.23, but the influence in zone-II showed that the tick infestation increased in rate 0.22.

Table (5): Distribution and ratio of ticks according to sex.

Specimens of adult ticks		Male No.& %	Female No&.%	Total No.& %	♂/♀
Rhipicephalus sanguineus	*N0*	27	63	90	
	%	(30.0)	(70.0)	(7.7)	1:2
Rhipicephalus turanicus	*N0*	110	241	351	
	%	(31.3)	(68.7)	(29.9)	1:2
Hyalomma anatolicum anatolicum	*N0*	177	431	608	
	%	(29.1)	(70.9)	(51.9)	1:2
Hyalomma marginatum	*No*	40	82	122	
	%	(32.8)	(67.2)	(10.5)	1:2
Total	N0	354	817	1171	1:2
	%	29.4	70.6		

Table (6): Number and percentage of tick stages on the infested sheep in different flocks.

Tick stage	Tick species				Total Ticks No.& %
	Rhipicephalus spp. No.& %		*Hyalomma* spp No& %		
	R. s	*R. t*	*H a. a*	*H. m*	
-Adult female					
- Engorged female	39 (7.0)	147 (26.5)	319 (57.6)	49 (8.9)	554 (47.3)
- Non-engorged Female	24 (9.1)	94 (35.7)	112 (42.6)	33 (12.5)	263 (22.5)
Total N0.	63	241	431	82	817
Adult male	27 (7.6)	110 (31.1)	177 (50)	40 (11.3)	354 (30.2)
Nymph	0		0		0
Larvae	0		0		0
Total	441		730		1171

Table (7): Number and percentage of ticks on body site of sheep.

Site of body	*Rhipicephalus.* spp		*Hyalomma.* Spp		Total ticks No. and %
	R. s No. and %	*R. t* No. and %	*H. a.a* No. and %	*H. m* No. and %	
Ear	52 (10.6)	159 (32.3)	248 (50.4)	33 (6.7)	492 (42.0)
Eyelid	1 (5.0)	8 (40.0)	10 (50.5)	1 (5.0)	20 (1.7)
Under axilla	8 (7.6)	30 (28.6)	47 (44.8)	20 (19.0)	105 (9.0)
Between Thigh	6 (5.4)	35 (31.2)	55 (49.1)	16 (14.3)	112 (9.6)
Udder	9 (6.5)	37 (26.6)	82 (59.0)	11 (7.9)	139 (11.9)
Testes	7 (7.4)	29 (30.5)	56 (58.9)	3 (3.2)	95 (8.1)
Under tail	7 (3.4)	53 (25.5)	110 (52.9)	38 (18.2)	208 (17.7)
Total	90 (7.7)	351 (30.0)	608 (51.9)	122 (10.4)	1171

Table (8): Number and percentage of infested sheep with hard ticks (Ixodidae) related to monthly occurrence in different zones in Suliamani governorate.

Months	Zone-I			Zone-II			Zone-III		
	No. sheep examined	No. sheep infested	Sheep infested %	No. sheep examined	No. sheep infested	Sheep infested %	No. sheep examined	No. sheep infested	Sheep infested %
March	85	9	10.6	90	11	12.2	85	21	24.7
April	110	18	16.4	95	19	20.0	100	27	27.0
May	95	21	22.0	90	21	23.3	75	27	36.0
June	90	16	17.8	90	18	20.0	60	15	25.0
July	65	9	13.8	90	13	14.4	80	8	10.0
August	70	6	8.6	60	6	10.0	75	6	8.0
September	70	4	5.7	80	4	5.0	60	3	5.0
October	50	2	4.0	40	2	5.0	50	2	4.0
November	50	0	0	55	0	0	50	1	2.0
December	50	0	0	60	0	0	60	0	0
January	55	0	0	50	0	0	75	0	0
February	50	0	0	50	0	0	60	9	15.0
Total	840	85	10.1	850	94	11.1	830	119	14.3
M ± SE	12.36 ± 2.2 a			13.73 ± 2.46 a			15.67± 3.7 a		
Total Number sheep	2525								
Total number of infested sheep	298								

Numbers with the same letter within a column are not significantly different from each other according to Duncan's multiple range tests ($P \leq 0.05$).

The data in table (10) shows the total number of tick which infested per sheep was 3.5, 3.9, and 4.2 in zone-I,II, and III, respectively during the study and the highest number of ticks infested per sheep was in May 4.1, 4.7 and 5.0 in all zones respectively, and the lowest number was detected in October and absent in November till February in

all zones, except in zone-III, the number of tick per infested sheep was one in November and 3.4 in February.

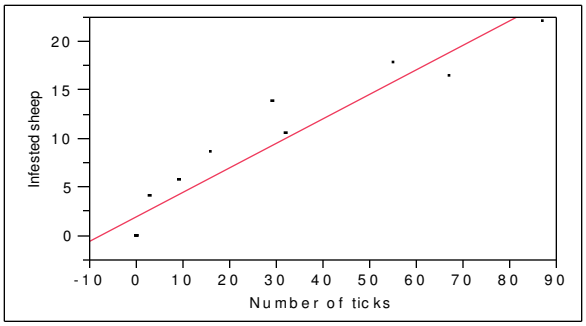
Table (9): Number of ticks collected from sheep from different zones.

Months	Zone-I	Zone-II	Zone-III
	No. of tick collected	No. of tick collected	No. of tick collected
March	32	41	81
April	67	87	129
May	87	98	134
June	55	77	67
July	29	46	32
August	16	11	21
September	9	6	5
October	3	3	3
November	0	0	1
December	0	0	0
January	0	0	0
February	0	0	31
Total	298	369	504
M ± SE	37.25a± 10.51	46.12a± 13.39	50.4a± 15.88
Overall ticks		1171	

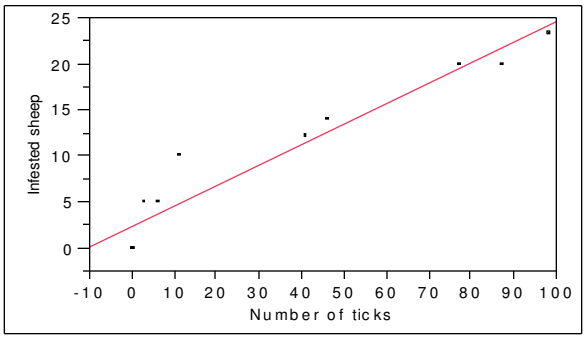
Numbers with the same letter within a raw are not significantly differed from each other according to Duncan's multiple range tests ($P \leq 0.05$).

Table (10): Ratio of hard ticks per sheep in different zones in Suliamani Governorate.

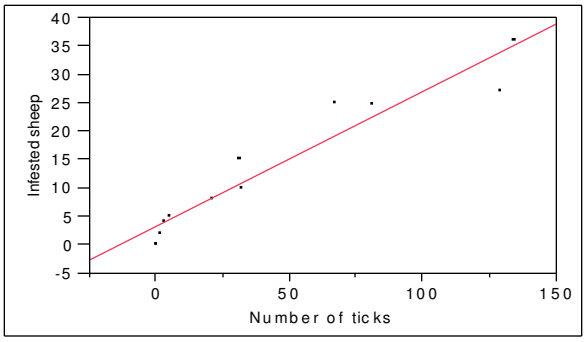
Months	Zone-I	Zone-II	Zone-III
	No. Tick / infested sheep	No. Tick / infested sheep	No. Tick / infested sheep
March	3.6	3.7	3.9
April	3.7	4.6	4.8
May	4.1	4.7	5.0
June	3.4	4.2	4.5
July	3.2	3.5	4
August	2.7	1.8	3.5
September	2.3	1.5	1.7
October	1.5	1.5	1.5
November	0	0	1
December	0	0	0
January	0	0	0
February	0	0	3.4
Total	3.5	3.9	4.2



A-zone-1: Infested sheep (Y) =2.0 + 0.25 (X) (X=Number of ticks). $R^2 = 0.91$*.



B-zone-II: Infested sheep (Y) = 2.3 + 0.22 X (X=Number of ticks). $R^2 = 0.91$*.



C-zone-III: Infested sheep = 3.1+ 0.23 X (X=Number of ticks). $R^2 = 0.92$**

Figure (4; A, B and C): Linear equation of estimation of infested (%) with number of ticks in 3 different zones.

Discussion

In this study the survey of ticks was carried out in Sulaimani governorate to show the prevalence of tick infestation in sheep, and it was observed the rate of 11.8% in all three geographic zones (zone-I, II, III), but the rate

differed in the three zones 2.0, 2.2 and 3.1, respectively. Four species of ticks were observed; *H. anatolicum anatolicum* 608(51.9%), *Hyalomma marginatum* 122 (10.4%), *Rhipicephalus turanicus* 351 (30%), and *Rhipicephalus sanguineus* 90 (7.7%). *H. a. anatolicum* was common and dominant species collected among infested sheep in the foothills and plane areas zone-III followed by *Rhipicephalus turanicus* in the mountainous area zone-I.

Hawa *et al.* (10) observed that the *H. anatolicum anatolicum* is the highly and widely distributed ixodidae tick, incriminating Iraqi livestock and causing substantial economic loss to livestock development worldwide. *H. anatolicum anatolicum* is adapted to conditions in dry areas where a constant supply of hosts may not be available. Razmi *et al*. (11) demonstrated five ixodid species from sheep and goats, the *Rhipicephalus sanguineus* and *Hyalomma marginatum*, were the most common species in sheep and goats. Other tick species encountered were *H. anatolicum anatolicum*, *H. asiaticum* in sheep in Iran. While Nasiri *et al.* (12) identified two genera (*Hyalomma* and *Haemaphysalis*) and five species including *Hyalomma marginatum* (44.67%), *H. anatolicum* (43.17%), *H. asiaticum* (6.37%), *H. dromdareii* (5.55%), *Haemaphysalis sulcata* (0.24%) and the rate of tick frequency in mountainous region was 48.15% and it was 51.85% in plateau regions and the rate of tick infestation in sheep was 11.41% in Abdanan, Iran.

The number of ticks per infested sheep in zone I, II and III were (3.5, 3.9, and 4.2) respectively during the study according to the month or season, this difference occurred may be due to change of environmental condition, and showed that the higher number of ticks per infested sheep was in May (4.1, 4.7 and 5.0) in zone-I, II and III, respectively, and indicated that ticks were present on sheep during every month of the year but there was a reduction in the number of ticks per sheep during the dry season.

Robson and Robb (13) described that in June and August the overall average of 29.8 ticks per infested animal is comparatively heavy compared to the 8.3 ticks per infested animal in 4 Governorates of Baghdad, Kut, Amara, and Basra in March and April in 1965, Iraq. Robson *et al.* (14) found that the average number of ticks per infested animal was 31.3 in June and August in 4 Governorates of Hilla, Karbala, Diwaniya and Nasiriya in Iraq. The distribution of tick species influenced by the seasons/month during the year, showed fluctuations in the occurrences and observed the number of ticks from March to July in 2009 – February, 2010 immediately following the beginning of rainy season, such as the number of *Hyalomma a. anatolicum* which was high in March, April, May, and June, *Rhipcephalus sanguineus* is highly distributed in April, May, and June and *Hyalomma marginatum* was highly distributed in April and May in zone-III (Garmian region). The number of *Rhipicephalus turanicus* was highly distributed in April and May in zone-I (Pishder region), and showed the highest number of *Hyalomma spp*. collected in spring and summer in zone-II and zone-III, while the highest number of *Rhipicephalus turanicus* collected in zone-I, this difference may be due to the environmental conditions in both seasons which are favorable to growth and development.

The main spring season was an optimum suitable environment for this distribution (suitable for activity of ticks, growth, development and reproduction in all zones in Sulaimani governorate), while the number of ticks decreased significantly in either fall and winter season, and it was found that the main role of this differences among the zones according to the humidity, temperature and rainfall, i.e. the relation of humidity in spring season reached up to 88%, 89%, and 83% in zone-I, II and III, respectively, when temperature was favorable (25°C, 26°C, and 28 °C) in zone-I, II, and III respectively with exist the rainfall in the season, may be suitable for the growth and development of tick distribution

In summer high temperatures (39°C) in zone-I, (42°C) in zone-II and (33°C) in zone-III were unfavorable for growth and combined with insufficient relative humidity which reached up to 64%, 28%, and 22% in zone-I, zone-II, and zone-III respectively with absent rainfall in all zones. While the relative humidity of fall reached to a favorable range of tick growth but combined with a high temperature of 30°C, 32°C, and 35°C in zone-I, II, and III respectively, which are showed the unfavorable conditions for tick development and growth, that will explain the low number of tick infestation among zones.

In winter the relative humidity with 96%, 96%, and 92% in zone-I, II, and III and lower temperature 16°C and 19°C in zone-I and II and absent of ticks, while few number of ticks appeared in zone-III, because the relative humidity (93%) and temperature (22°C) was favorable for growth of ticks. Abadi *et al.* (15) revealed that the high prevalent of ticks occurrence during summer and spring, and the density and activity of ticks in winter was low. The highest seasonal activity was observed in spring and the lowest seasonal was in winter (12).

It was found that the rainfall was a main climatic factor which influences the seasonal variation in tick infestation as from June to November, the rainfall and humidity were low, and there was sharp reduction in number of ticks. This finding is in agreement with (16). Ixodid ticks are very sensitive to desiccation and cannot survive relative humidities of less than 80% for any length of time (17). Jain and Jain (18) showed that the genus *Hyalomma* is tough and hard and can survive in low humidity and extreme climatic conditions.

In this study, the ratio of male to female was 1:2 and the females were dominant in number, percentage of female 70.6% was higher than male 29.4% in all species of ticks

and showed the highest number of females recorded, *Hyalomma a. anatolicum* and *Rhipicephalus turanicus.*

Fourie *et al*. (19) showed that the female was dominant in domestic stock and wild ungulates, except on adult on angora goats where the sex ratio was biased in favour of the males, the sex ratio is an important parameter which characterized the state and dynamics of natural populations of animals and the monthly variations in the sex ratio of the tick on hosts are believed to be related to the large fluctuations in sex ratios of questing ticks. Ogorea *et al.* (20) found that the main attachment sites of fully engorged female of ixodid ticks were ears, head, body sides, perianal and scrotal/udder regions. Over the three sampling periods, 87% of the ticks counted were on the ears in sheep.

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