Diversity and distribution of ticks from domestic ruminants in Lebanon

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Domestic ruminants,
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Lebanon.

Summary
Ticks (Acari: Ixodidae) are ectoparasites infesting livestock in every geographic area in the world and they are vectors of several viral, bacterial, and protozoan pathogens to animals and humans worldwide. A deep knowledge of the geographical distribution of these arthropods would have a key role in the control of tick-borne diseases. Few data are available about tick presence in domestic ruminants in Lebanon. The study aimed at providing an analysis of tick presence and distribution in Lebanon. Ticks were collected from cattle, sheep, and goats farms distributed in 6 Lebanese provinces between June and September 2014. A total of 272 adult hard ticks were randomly collected from domestic ruminants (cattle, sheep, and goats) located at 37 Lebanese farms, distributed among 30 villages. Ticks belonged to 4 Ixodidae genera: *Rhipicephalus* (72.4%), *Haemaphysalis* (11.4%), *Dermacentor* (8.1%), and *Hyalomma* (8.1%). They included the following species: *Rhipicephalus annulatus* (50.7%), *Rhipicephalus turanicus* (18.8%), *Hyalomma anatolicum* (8.1%), *Haemaphylasis punctata* (11.4%), *Dermacentor marginatus* (8.1%), *Rhipicephalus sanguineus* (2.5%), and *Rhipicephalus bursa* (0.4%). *Rhipicephalus turanicus* and *H. anatolicum* were found on cattle, sheep, and goats, *R. annulatus* on cattle and sheep, *R. sanguineus, D. marginatus* and *Hea. punctata* on sheep and goats, while *R. bursa* was collected only on sheep. Tick species involved in pathogen transmission were found and some of the identified species were recorded in Lebanon for the first time.

Varietà e distribuzione di zecche in ruminanti domestici in Libano

Parole chiave
Ixodidae,
Libano,
Ruminanti domestici,
Zecche dure.

Riassunto
Le zecche (Acari: Ixodidae) sono ectoparassiti in grado di infestare gli animali domestici in tutte le aree geografiche del pianeta e di trasmettere numerosi virus, batteri e protozoi patogeni sia per gli animali sia per gli esseri umani. Una conoscenza approfondita della distribuzione geografica di questi artropodi potrebbe avere un ruolo chiave nel controllo delle malattie trasmesse da zecche. Pochi dati sono disponibili riguardo alla presenza di zecche nei ruminanti domestici in Libano. Il presente studio ha avuto come obbiettivo analizzare la presenza e la distribuzione delle zecche in Libano. Le zecche sono state prelevate da bovini, ovini e caprini presenti in aziende libanesi, localizzate in 6 province. Il campionamento è stato effettuato nel periodo compreso tra giugno e settembre del 2014. Un totale di 272 esemplari adulti di zecche dure è stato prelevato in maniera casuale da ruminanti domestici (bovini, ovini e caprini) appartenenti a 37 aziende libanesi, localizzate in 30 villaggi. Le zecche appartengono a 4 generi di Ixodidae: *Rhipicephalus* (72,4%), *Haemaphysalis* (11,4%), *Dermacentor* (8,1%) e *Hyalomma* (8.1%). Le specie di zecche identificate includono: *Rhipicephalus annulatus* (50,7%),

Rhipicephalus turanicus (18,8%), *Hyalomma anatolicum* (8,1%), *Haemaphylasis punctata* (11,4%), *Dermacentor marginatus* (8,1%), *Rhipicephalus sanguineus* (2,5%) e *Rhipicephalus bursa* (0,4%). *Rhipicephalus turanicus* e *H. anatolicum* sono state prelevate da bovini, ovini e caprini; *R. annulatus* è stata rivenuta su bovini e ovini, *R. sanguineus, D. marginatus* e *Hea. punctata* su ovini e caprini; mentre *R. bursa* è stata riscontrata solo su ovini. Il presente studio ha permesso di riscontrare la presenza di alcune specie di zecca implicate nella trasmissione dei patogeni in Libano. Per alcune specie, la presenza in Libano è stata documentata per la prima volta.

Introduction

Ticks are obligate blood-sucking ectoparasites of mammals, birds, and reptiles. They affect human and animal health.

The impact of ticks is related to their ability to transmit diseases to humans and animals (Rajput 2006). Hence, ticks are responsible for severe economic losses in livestock both through direct and indirect effects. Direct effects can occur in several ways, as blood sucking can cause reduction in live weight, can limit livestock production, and can induce anaemia among domestic animals. Tick bites reduce the quality of hides and may cause irritation and serious physical problems to ruminants. Indirect effects can be due to the injection by certain ticks (*Dermacentor andersoni*) of a toxin causing paralysis (Durrey *et al.* 2012). In addition, ticks are vectors of several pathogens (virus, bacteria, protozoa, and filarial nematodes), which can cause diseases in animals and humans worldwide (Dantas-Torres 2008).

Approximately 878 tick species are known, the most of which belong to the 2 main families, *Ixodidae* and *Argasidae* (Anderson *et al.* 2008).

Due to their impact on human and animal health, as well on livestock production, the knowledge about the regional distribution and abundance of tick species is important.

Lebanon is located at the crossroads of the Mediterranean Basin and the Arabian hinterland. The Country belongs to the Mediterranean climatic zone, with rain falling during the winter and pronounced drought during the Summer. Studies on ticks prior to the present one have been conducted in Lebanon. However, the available information on tick distribution in Lebanon is scanty. Seven tick species have been reported to be endemic in Lebanon: *Rhipicephalus annulatus* (found on bovine in North Lebanon), *Hyalomma aegyptium* (on tortoise in Saida, Jezzine, Aatanit, Furzol, and in Batroun), *Hyalomma sculzei* (Camels without information about region distribution). No data have been reported about host and distribution for the 4 tick species, namely: *Rhipicephalus sanguineus, Hyalomma anatolicum, Hyalomma excavatum* and *Dermacentor marginatus* (ElRai 2011, Apanaskevich *et al.* 2006, Hoogstraal *et al.* 1985, Otranto *et al.* 2014)[1].

The study aims to overcome the lack of data regarding tick presence on domestic animals in Lebanon by providing a survey of tick species presence and abundance in farms of ruminants in this country. A deeper understanding of the abundance of tick species involved in pathogens transmission, as well as their geographical distribution, is pivotal in controlling tick-borne diseases (TBDs) in the future.

Materials and methods

Geographic area and sampling period

The study was carried out into the following

[1] http://www.icttd.nl, http://www.phsource.us.

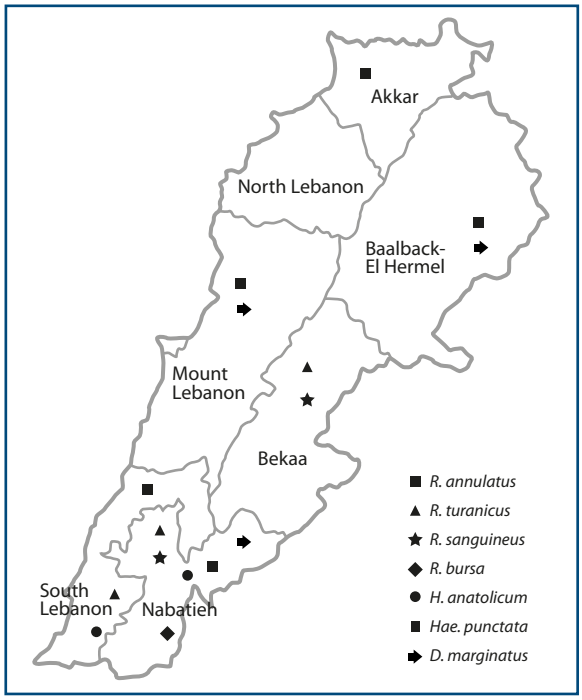

Figure 1. *Map of Lebanon showing the geographic distribution of ticks in the 6 Lebanese provinces.*

Table I. *Distribution of temperature and relative humidity in the 6 Lebanese provinces between June and September 2014.* Data obtained from the Lebanese Agricultural Research Institute.

Provinces	Month	Average Minimum Temperature ± Standard deviation	Average Maximum Temperature ± Standard deviation	Average Minimum Relative Humidity	Average Maximum Relative Humidity
Akkar	June	16± 3.7	24.23±4.26	23%	93.5%
Baalback-El Hermel	Sep	16.7± 1.45	30±2.34	46.2%	71.2%
Mount Lebanon	Sep	18.0±1.2	25.84±1.2	58.6%	94.1%
Bekaa	June	11.41±2.25	29.1±4.23	29.4%	66.3%
Nabatieh	June	17.5± 1.5	29± 3.6	21.1%	86.5%
	Sep	18.5±1.3	29.35±1.44	56.2%	82.4%
South Lebanon	June	21.15±1.17	28.6±2.85	25.6%	81.8%

6 Lebanese provinces: Akkar, Baalback-El Hermel, Bekaa, Mount Lebanon, Nabatieh, and South Lebanon (Figure 1). Being Lebanon characterised by a mild Mediterranean climate, tick collection was carried out in June 2014 in Akkar, Bekaa, Nabatieh and South Lebanon provinces, where late Spring and early Summer represent the period of tick activity. Moreover, in some farms of Nabatieh, a second tick sampling was also carried out in September 2014. In Baalback-El Hermel and Mount Lebanon provinces, where the weather is very moist, samples were collected in September 2014 (late Summer - early Autumn) (Table I).

Tick collection and storage

Ticks were collected from domestic animals (adult/young) in 37 farms distributed among 30 villages, where acaricide are not in use (Tables II and III). Farms were characterised by different kinds of breeding, including imported and local races, and mixed or mono species (Table IV).

Ticks were collected in the morning or in the evening on animals by using fine forceps avoiding crushing the arthropods (Walker *et al.* 2014). The arthropods were found mainly in the animal back, neck, ear, and mammary glands (Figures 2, 3, 4 and 5). Ticks collected from the host were stored in sealable vials containing 70% ethanol (Pérez-Eid 2009).

Tick genus and species identification

Adult hard ticks were identified under a stereomicroscope analysing the external morphological characteristic using morphological keys reported in literature (Hoogstraal *et al.* 1985, Walke *et al.* 2014, Pérez-Eid 2009).

Ticks were heated at 45°C in 10% KOH for a time ranging between 12 and 48 hours depending on the thickness of cuticle, which varies among the different tick species. Ticks were washed twice with distilled water and stained with Lugol's Iodine for 15-30 minutes (Walker *et al.* 2014). Ticks were then washed and fixed by using increasing grades of alcohol 20%, 40%, and 70% for 10 minutes, respectively (i.e. fixing the tick in each grade of alcohol for 10 minutes), and were subsequently mounted on glass slides in Hoyer's medium followed by hardening and drying at 45-50°C for 4-5 days. Morphologically identificationof ticks was carried out using a microscope and reference taxonomic keys (Walker *et al.* 2014, Pérez-Eid 2009, Meddour *et al.* 2006, Hoogstraal *et al.* 1959, Kaiser *et al.* 1974).

Table II. *Distribution of farms in 6 Lebanese provinces.*

Breeding	Provinces	Number of visited farms	Number of ticks in untreated farms
Bovine	Akkar	4	25
	Nabatieh	8	68
	South Lebanon	2	17
	Bekaa	0	0
Ovine	Akkar	1	6
	Baalback-El Hermel	1	7
	Bekaa	2	8
	Mount Lebanon	1	3
	Nabatieh	2	16
	South Lebanon	0	0
Caprine	Baalback-El Hermel	2	12
	Mount Lebanon	3	22
	Nabatieh	2	16
Bovine/ Ovine	Nabatieh	1	7
	South Lebanon	1	10
Bovine/ Caprine	Akkar	1	6
	South Lebanon	1	6
Caprine/ Ovine	Akkar	1	6
	Nabatieh	2	25
Bovine/ Caprine/ Ovine	South Lebanon	2	12
Total		**37**	**272**

In presence of ticks in a poor state of preservation or showing a doubtful morphological identification of species, a molecular identification of tick species was conducted. For this purpose, DNA was extracted from single specimens using the Pure link Genomic DNA Kit (Thermo Fisher™ Applied Biosystems™, Waltham, MA, USA) according to the manufacturer's instruction. A fragment of 360 base pairs (bp) of the mitochondrial small subunit 12SrRNA gene was amplified by polymerase chain reaction (PCR), the PCR primers were: forward primer T2A: 5'AAATGAGAGCGACGGGCGATGT3'and reverse primer T1B: 5'AAACTAGGATTAGATACCCT 3', followed by sequencing (Beati *et al.* 2001, Shemshad *et al.* 2011).

The PCRs were carried out in a final volume of 50 µl, including: 50-100 ng of DNA, forward and reverse primers 200 nM; each dNTPs 200 µM, 1.25 U of Taq Polymerase; $MgCl_2$ 1mM and the appropriate buffer 1X. Conventional PCR was carried out in a Thermo Fisher™ Applied Biosystems™ 2720 Thermal Cycler (Waltham, MA, USA). Thermal protocol included: an initial denaturation at 95°C for 15 minutes, followed by 35 cycles of denaturation

Table III. *Coordinates of the geographical Lebanese areas in which tick collection occurred.*

Province	Place of collection	Latitude	Longitude	Altitude
Akkar	Adbel	34°32'6"N	36°57'50.4"E	300 m
	Bazbina	34°31' 0" N	36°12'0"E	955 m
	El Kantara	34°31'33.078"N	36°00'3.0711"E	375 m
	Machha	34°32'25"N	36°7'56"E	349 m
	Machha	34°32'25"N	36°7'56"E	349 m
	Michmich	34°21'24.0012"N	35°55'51"E	1,100 m
	Sahel Halba	34°33'2" N	36°4'41"E	120 m
Baalback-ElHermel	Chaat	35°00'30"N	36°00'36"E	1,000 m
	Chaat	35°00'30"N	36°00'36"E	1,000 m
	El Hermel	34°23'N	36°23'E	1,000 m
Bekaa	Zahle	33°50'48"N	35°54'07"E	963 m
	Zahle	33°50'48"N	35°54'07"E	963 m
Mount Lebanon	Fakra	34°00'0.1002"N	35°48'18"E	1,140 m
	Kfardibyan	34°00'39.90"N	35°49'29.38"E	1,200 m
	Laklouk	34°7'59. 16"N	35°51'14.04"E	2,000 m
	WataHrajiliyi	34°00'1.032"N	35°47'36. 96"E	1,400 m
Nabatieh	AynEbel	33°00'42"N	35°14'24"E	800 m
	AynEbel	33°00'42"N	35°14'24"E	800 m
	AynEbel	33°00'42"N	35°14'24"E	800 m
	El Koulayaa	33°19'48"N	35°34'12"E	650 m
	El wazani	33°16'32"N	35°37'22"E	279 m
	El wazani	33°16'32"N	35°37'22"E	279 m
	El wazani	33°16'32"N	35°37'22"E	279 m
	Hasbaya	33°23'N	35°41'E	750 m
	Ibel El Saki	33°12'36"N	35°22'48"E	800 m
	Kafarkila	33°10'12"N	35°19'48"E	700 m
	Marjiiyoun	33°30'N	35°30'E	860 m
	Mayfadoun	33°20'9.6"N	35°27'43.2"E	470 m
	Rmeich	33°00'54"N	35°24"E	690 m
	Wata El Khiyam	33°19'37.8"N	35°36'40"E	700 m
	Zawtar El Charkieh	33°19' 33"N	35°28'34"E	475 m
South Lebanon	Ayn El Deleb	33°32'40.87"N	35°24'25.834"E	41 m
	Barich	33°16'22"N	35°21'9"E	358 m
	El Bourghliyi	33°18'36"N	35°14'24"E	19 m
	Maaroub	33°17'6"N	35°20'49.2"E	270 m
	Qinarit	33°30'17"N	35°22'44"E	233 m
	Zayta	33°30'29"N	35°23'03"E	300 m

Table IV. *Details of tick collection done from ruminants in 6 provinces of Lebanon.*

Province	Collection Month in 2014	Kind of farms	Number of ticks	Tick species
Akkar	June	Bovine	25	*R. annulatus*
		Ovine	6	*R. annulatus*
		Ovine/Caprine	6	*R. annulatus*
		Bovine/ Caprine	6	*R. annulatus*
Baalback-El Hermel	September	Ovine	5	*Hae. punctata*
			2	*D. marginatus*
		Caprine	5	*Hae. punctata*
			7	*D. marginatus*
Bekaa	June	Ovine	6	*R. turanicus*
			2	*R. sanguineus*
Mount Lebanon	September	Ovine	3	*Hae. punctata*
		Caprine	9	*Hae. punctata*
			13	*D. marginatus*
Nabatieh	June	Bovine	57	*R. annulatus*
			8	*H. anatolicum*
			3	*R. turanicus*
		Ovine	15	*R. turanicus*
			1	*R. sanguineus*
		Caprine	7	*R. turanicus*
			3	*R. sanguineus*
			2	*H. anatolicum*
	September	Caprine	4	*Hae. punctata*
	June	Bovine/Ovine	7	*R. turanicus*
		Caprine/Ovine	8	*R. turanicus*
			1	*R. sanguineus*
			1	*R. bursa*
			10	*H. anatolicum*
	September	Caprine/Ovine	5	*Hae. punctata*
South Lebanon	June	Bovine	17	*R. annulatus*
		Bovine/Ovine/ Caprine	7	*R. annulatus*
			5	*R. turanicus*
		Bovine/Ovine	8	*R. annulatus*
			2	*H. anatolicum*
		Bovine/ Caprine	6	*R. annulatus*
Total			**272**	

at 95°C for 30 seconds, annealing at 51°C for 30 seconds, and elongation at 72°C for 1 minute. A final extension at 72°C for 5 minutes was carried out. The PCR products were visualized under UV light after electrophoresis on 1.5% agarose gel containing 1X SYBRSafe (Thermo Fisher™ Applied Biosystems™ Waltham, MA, USA). Amplicons were purified via vacuum filtration using the Machery Nagel NucleoFast 96 PCR Plate (Thomas Scientific, GmbH & Co. KG, Swedesboro, New Jersey, USA) following manufacturer's instructions. Sequencing reactions were carried out using the Big Dye Terminator Cycle Sequencing V1.1 (Thermo Fisher™ Applied Biosystems™ Waltham, MA, USA) in a 10 µl of final volume including BigDye™ Terminator v1.1/ v3.1 Sequencing Buffer (1X), primer 0.5 µM and about 10 ng of purified PCR products.

Sequencing reactions were purified using Sephadex plates (Millipore, Billerica, MA, USA) following manufacturer's instructions and stored at +4°C until analysed. Sequencing reactions were performed on an ABI 3130X Genetic Analyser sequencer (Thermo Fisher™ Applied Biosystems™ Waltham, MA, USA), and sequence trace files were assembled using the multi-sequence alignment software Chromaspro (v.2.1.1). The sequences were compared with the ones present in Genbank using the Basic Local Alignment Search Tool.

Results

A total of 272 adult hard ticks were collected from domestic ruminants in 6 Lebanese provinces. Female

Figure 2. *Ticks on mammary glands of cow.*

Figure 4. *Ticks on the neck of cow.*

Figure 3. *Ticks in the back of cow.*

Figure 5. *Two ticks in the ear of goat.*

ticks were the 77.6% of the collected ticks, while male ticks represented the 22.4%. Ticks belonged to 4 genera, among which *Rhipicephalus* genus represented the highest frequent (72.4%) with respect to the other identified genera: *Heamaphysalis, Dermacentor,* and *Hyalomma*. Seven tick species were identified within the Ixodidae family (Table IV). Molecular analysis confirmed morphological identification for all the doubtful samples. Collected ticks included: *Rhipicephalus turanicus* and *Hyalomma anatolicum*, which were found on cattle, sheep, and goats; *Rhipicephalus annulatus* collected on cattle and sheep; *Rhipicephalus sanguineus, Dermacentor marginatus,* and *Heamaphysalis punctata* found on sheep and goats; while *Rhipicephalus bursa* was collected only on sheep (Table V).

One hundred and thirty-seven, 69, and 66 ticks were collected from cattle, sheep, and goats, respectively. The samples were spread across different Lebanese provinces as described below (Table VI). *Rhipicephalus annulatus* and *H. anatolicum* were the dominant ticks on cattle, *R. turanicus* and *R. sanguineus* were the prevalent species on sheep, while *Hae. punctata* and *D. marginatus* were the most frequently ticks collected on goats.

Out of the identified tick species, 5 where collected in June and – with the exception of *R. bursa* which were reported only at 650 m of altitude – the other 4 species occurred in both plain and mountainous areas. *Rhipicephalus annulatus* was found indeed in an altitude ranging from 19 m to 1,100 m, *R. turanicus* from 270 m to 963 m, *R. sanguineus* was collected in an altitude ranging from 270 m to 963 m, and *H. anatolicum* was found from 400 m to 860 m.

In September, other 2 tick species were collected in mountainous areas: *Hae. punctata* from 700 m to 2,000 m and *D. marginatus* from 1,000 m to 1,400 m.

Discussion

Lebanese provinces are characterised by a heterogeneous vegetation (pine, fir, oak, willow and cypress) and climate (temperature and humidity) and by the presence of livestock, which plays a very important role for the distribution, activity, growth, development, diversity, and reproduction of ticks.

The present study allowed for identifying 7 tick species in Lebanon (Table IV).

In particular, *R. sanguineus* is a monotropic (all developmental stages feed on the same host species), three-host (each life stage requires a new host to feed on) tick species (Dantas-Torres, 2010). It is typically located in warmer climates and its mainly host is dog, but it can feed also on ruminants. It has a hexagonal capituli and has been recorded worldwide, namely in India, Iran, China, Iraq, Bulgaria, and Europe (Kaiser *et al.* 1974, Lu *et al.* 2013, Ramezani *et al.* 2014, Shemshad *et al.* 2012, Toledo *et al.* 2009, Chhillar *et al.* 2014, Sarani *et al.* 2014, Yakhchali *et al.* 2011). *Rhipicephalus annulatus* is a typical one-host tick and its entire life cycle from larva to mated adult is confined to a single host and can be completed in 2 months (EFSA 2010) and its hosts are ruminants. *Rhipicephalus annulatus* can survive in mesomediterranean environment[2] and is distributed in Algeria, Iran, Senegal, and Ethiopia (Yakhchali *et al.* 2011, Mediannikov *et al.* 2014, Pegram *et al.* 1981, Benchikh-Elfegoun *et al.* 2007).

Table V. *Distribution of hard ticks in different hosts in Lebanon.*

Host	*R. annulatus* %	*R. turanicus* %	*R. sanguineus* %	*R. bursa* %	*H. anatolicum* %	*Hae. punctata* %	*D. marginatus* %
Bovine	44.45	2.22	0	0	3.68	0	0
Ovine	6.25	11.42	1.43	0	1.84	3.70	0.74
Caprine	0	5.16	1.07	0.40	2.58	7.70	7.36

Table VI. *Percentage of hard ticks scattered in different Lebanese provinces.*

Province	*R. annulatus* %	*R. turanicus* %	*H. anatolicum* %	*Hae. punctata* %	*R. bursa* %	*R. sanguineus* %	*D. marginatus* %
Nabatieh	23.50	14.70	7.40	3.30	0.40	1.80	0
South Lebanon	11.40	1.80	0.70	0	0	0	0
Akkar	15.80	0	0	0	0	0	0
Bekaa	0	2.30	0	0	0	0.70	0
Baalback-El Hermel	0	0	0	3.70	0	0	3.30
Mount Lebanon	0	0	0	4.40	0	0	4.80
Total %	**50.70**	**18.80**	**8.10**	**11.40**	**0.40**	**2.50**	**8.10**

Rhipicephalus bursa is a two-host species, 1 life cycle is completed in a year, it feeds on ruminants and horses[2] and it can survive in the Mediterranean climatic region. It is scattered in Algeria, Iran, Iraq, Bulgaria, and Europe (Shemshad *et al.* 2011, Shemshad *et al.* 2012, Toledo *et al.* 2009, Sarani *et al.* 2014, Benchikh-Elfegoun *et al.* 2007, Hasson *et al.* 2012, Arnaudov *et al.* 2014). *Rhipicephalus turanicus* is a three host-tick, ruminants and domestic animals are its hosts. It can survive in desert and Mediterranean climatic regions[2]. It is distributed in Algeria, Iraq, and Europe (Shemshad *et al.* 2012, Pegram *et al.* 1981, Hasson *et al.* 2012). *Haemaphysalis punctata* is a three-host tick, ruminants, horses, and humans are its hosts and the entire life cycle can be completed in 1 year, although it usually takes 3 years[2]. It is spread in Bulgaria, Algeria, Hungary, United Kingdom, and Ukraine (Yakhchali *et al.* 2011, Benchikh-Elfegoun *et al.* 2007, Arnaudov *et al.* 2014, Gyuranecz *et al.* 2011, Akimov *et al.* 2012).

Dermacentor marginatus is a three-host tick, the entire life cycle can be completed in 1 year and it can parasitize different kind of hosts, such as dogs, cattle, sheep, horses, and humans. This tick has 11 festoons, rectangular form of the basis captuli, short mouth, and large enamel on scutum. It inhabits pastures, temperate forest while it is common under oak and pine vegetation. *Dermacentor marginatus* is present in the Mediterranean region, having it been reported in Algeria, Bulgaria, and several European countries (Yakhchali *et al.* 2011, Benchikh-Elfegoun *et al.* 2007, Arnaudov *et al.* 2014, Tijsse-Klasen *et al.* 2015). *Hyalomma anatolicum* is a three-host tick, ruminants and camels are its hosts. It is widely distributed in central Asia, Middle and Near East, Arabia, South-Eastern Europe and North Africa (Apanaskevich *et al.* 2006).

Identified tick species are relevant since they can be vector of several pathogens. In particular, Rhipicephaline, as *R. annulatus* and *R. turanicus*, can transmit the etiological agents of babesiosis, theileriosis, anaplasmosis, and rickettsiosis. *Rhipicephalus bursa* can transmit babesiosis in small ruminants (*Babesia ovis*) and cattle (*Babesia bigemina*), anaplasmosis in bovine (*Anaplasma marginale*), and small ruminants (*Anaplasma ovis*) (EFSA 2010, Satta *et al.* 2011). *Rhipicephalus sanguineus* has been recorded worldwide and is able to transmit pathogens such as *Coxiella burnetii* and species belonging to *Rickettsia, Ehrlichia*, and *Anaplasma* genera (Dantas-Torres 2008, Sarih *et al.* 2005).

Haemaphysalis punctata can transmit agents of babesiosis and theileriosis both in cattle and sheep. The tick was also associated with transmission of Tick borne encephalitis virus, Crimean-Congo haemorrhagic fever virus, and *Coxiella burnetii* (Satta *et al.* 2011).

Dermacentor marginatus can transmit several *Babesia* (*Babesia canis, Babesia divergens, Babesia ovis, Babesia caballi*), *Theileria* (*Theileria ovis, Theileria equi*) and *Rickettsia* (*Rickettsia conorii* and *Rickettsia slovaca*) species (Bonnet *et al.* 2013). This species has also been identified as one of the vectors of *Coxiella burnetii* (EFSA 2010).

Hyalomma anatolicum is considered vector of Crimean-Congo haemorrhagic fever virus, *Theileria* and *Babesia* species, *Anaplasma marginale* and arboviruses (Nabian *et al.* 2007).

This is the first survey of tick species infesting ruminants in Lebanon. A great diversity in tick species in domestic ruminants was reported and species that are known to transmit pathogens to animals and humans were found. Moreover, for the first time *Rhipicephalus turanicus* (Pomerantzev, 1940), *Rhipicephalus bursa* (Canestrini and Fanzago, 1878), and *Heamaphysalis punctata* (Canestrini and Fanzago, 1878) were detected in Lebanon.

Conclusions

The study permitted to identifying 7 tick species in domestic animals in Lebanon and it might serve as the starting point for future epidemiological studies.

Because of their ability to transmit pathogens to animals and humans, further studies are needed to analyse pathogens prevalence in Lebanese ticks. Characterization of tick-borne pathogens in their arthropod hosts will be relevant for epidemiological studies of tick-borne pathogens in Lebanon. Control of vector species abundance and distribution in association with the analysis of pathogen prevalence is essential to evaluate risks associated with pathogen transmission and to adopt suitable prevention measures to improve the health of both animals and humans.

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[2] http://www.icttd.nl.

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