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Ticks (Acari: Ixodida) parasitizing humans in Corum and Yozgat provinces, Turkey

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Abstract In order to identify ticks infesting humans in Corum and Yozgat provinces in Turkey, a total of 2110 ticks representing 14 species were collected on humans, between June and September 2009. Of those, 1551 (687♂, 450♀, 407 nymphs, 7 larvae) were collected from Corum and 559 (330♂, 180♀, 49 nymphs) were collected from Yozgat. The majority of ticks (n = 1121, 53.1 %) was *Hyalomma marginatum*. Other common ticks infesting humans were *Dermacentor marginatus* (n = 209, 9.9 %) and *Rhipicephalus turanicus* sensu lato (n = 145, 6.9 %) in the study area. In addition, a total of 386 immature *Hyalomma* were found on humans in Corum (335 nymphs, 7 larvae) and Yozgat (44 nymphs). *Ixodes laguri* and *Haemaphysalis erinacei taurica* were recorded for the first time in Corum. To the best of our knowledge, this study is the first detailed investigation on ticks infesting humans in Corum and Yozgat, except individual or incidental records. The present study provides useful information for those concerned with ticks and tick-borne diseases in Turkey.

Keywords Ticks · Human infestation · Corum · Yozgat · Turkey

Introduction

Ticks are among the most common human ectoparasites. Their bites are usually painless; therefore many people may not be aware of their bites. Ticks may be responsible for transmission of numerous viral, rickettsial, bacterial and protozoan disease agents (Estrada-

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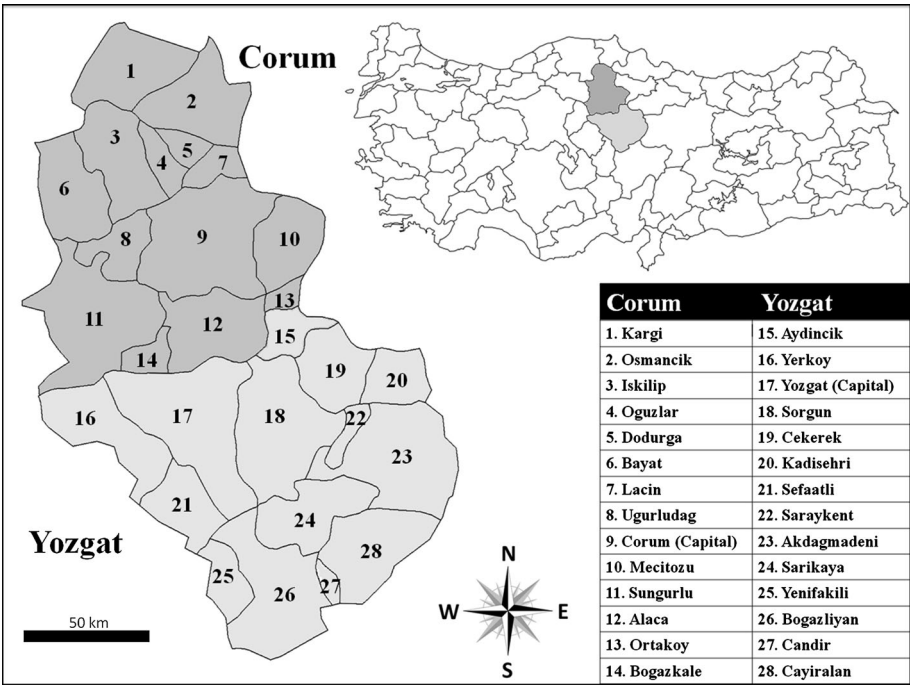
Peña and Jongejan 1999; Otranto et al. 2014). Irritation, allergic reactions, and rarely paralysis are other problems associated with tick bites (Jongejan and Uilenberg 2004).

Ticks are common throughout Turkey (Merdivenci 1969; Bursali et al. 2012) and thousands of people are affected by tick bites and tick-borne diseases in Turkey every year (Vatansever et al. 2008; Gargili et al. 2011; Bursali et al. 2013; Bakirci et al. 2014). Crimean-Congo hemorrhagic fever (CCHF), tularemia and rickettsiosis are some of the tick-borne diseases seen in Turkey (Tonbak et al. 2006; Yesilyurt et al. 2011; Kuloglu et al. 2012). Since 2002, when the CCHF was first detected, thousands of CCHF cases have been reported in Turkey. According to The Republic of Turkey Ministry of Health, between 2002 and December 2014, 9046 CCHF cases and 440 deaths were documented in Turkey.

To date, more than 700 hard tick species have been described throughout the world, 269 of which have been recognized as the cause of health-related problems for humans (Guglielmone et al. 2014; Apanaskevich and Apanaskevich 2015a, b). Turkish tick fauna currently consist of 47 tick species and 31 of them have been found on humans (Bursali et al. 2012; Keskin et al. 2014). It is known that collection and accurate identification of ticks is an essential step for further studies about ticks and tick-borne diseases (Marrelli et al. 2007; Estrada-Peña et al. 2013). Although few quantitative studies about ticks infesting human have been documented in several provinces (Vatansever et al. 2008; Gargili et al. 2011; Bursali et al. 2013; Bakirci et al. 2014), there is limited information on this issue in large parts of Turkey.

To the best of our knowledge, this study is the first detailed investigation on ticks infesting humans in Corum and Yozgat provinces, except individual or incidental records. The aim of this study is to determine the species composition of ticks infesting humans in



Corum	Yozgat
1. Kargi	15. Aydincik
2. Osmancik	16. Yerkoy
3. Iskilip	17. Yozgat (Capital)
4. Oguzlar	18. Sorgun
5. Dodurga	19. Cekerek
6. Bayat	20. Kadisehri
7. Lacin	21. Sefaatli
8. Ugurludag	22. Saraykent
9. Corum (Capital)	23. Akdagmadeni
10. Mecitozu	24. Sarikaya
11. Sungurlu	25. Yenifakili
12. Alaca	26. Bogazliyan
13. Ortakoy	27. Candir
14. Bogazkale	28. Cayiralan

Fig. 1 Map of the study area, Corum and Yozgat provinces, Turkey

Corum and Yozgat provinces. We believe that this study will provide useful information on ticks and tick-borne diseases for those interested.

Materials and methods

Study area

The study was conducted in 2 neighbor provinces (Fig. 1) of Turkey. Corum province (40°33′00″ N, 34°57′14″ E) is situated on Middle Black Sea in Black Sea Region and divided into 14 districts (see Fig. 1). The climate of Corum province is mainly steppe, but Kargi, Osmancik, Iskilip, Lacin, Dodurga, Oguzlar and Bayat districts are under the influence of oceanic climate. Forests cover about 28 % of the province. The province covers 12,820 km^2 areas. The mean altitude is 801 m and the mean annual precipitation is 429 mm. At present, approximately 527 thousand people live in the province; 71 % person lives in urban, 29 % person lives in rural areas.

Yozgat province (39°49′15″ N, 34°48′30″ E) is located in the Middle Kızılırmak Basin in the Central Anatolia Region. Yozgat province has 14 districts (see Fig. 1). The main climate of Yozgat province is continental, but the oceanic climate is seen in some regions. The predominant vegetation of Yozgat province is steppe and forests cover just about 9 % of the province. The province covers an area of 14123 km^2. The mean altitude is 1418 m and the mean annual precipitation is 554 mm. At present, approximately 450 thousand people live in the province; 59 % person lives in urban, 41 % person lives in rural areas.

Ticks collection and morphological identification

Between June and September 2009, ticks were collected on humans by doctors, nurses, or health technicians under aseptic conditions in the major hospitals and local health clinics of Corum and Yozgat provinces and stored in 70 % alcohol. Afterward, ticks were deposited in the Acarology laboratory in Gaziosmanpasa University (Tokat, Turkey) for taxonomic identification. Tick samples were identified to species under the stereomicroscope (Leica MZ16, Germany). The adult ticks were identified using the morphological keys of Filippova (1977, 1997), Walker et al. (2000) and Estrada-Peña et al. (2004), while the immature ticks were identified using keys and descriptions by Filippova (1977, 1997) and Apanaskevich and Horak (2008).

Results

In total, 2110 ticks representing 14 different species were collected on 2085 humans in Corum and Yozgat provinces, between June and September 2009. Of those, 1551 (687♂, 450♀, 407 nymphs, 7 larvae) were collected from Corum province while 559 (330♂, 180♀, 49 nymphs) were collected from Yozgat province. Twelve tick species were identified in

Table 1 Ticks infesting humans in Corum province and its districts

Tick species	Alaca	Bayat	Corum[a]	Dodurga	Iskilip	Kargi	Lacin	Mecitozu	Oguzlar	Ortakoy	Osmancik	Sungurlu	Ugurludag	Total
D. marginatus	8♂ 1♀ 15N	1♂	12♂ 10♀ 10N		1♂ 2♀ 1N	3♂ 5♀ 1N	1♂	9♂ 10♀ 8N	1♂ 1♀ 1N	1N	3♀ 3N	3♂ 2♀ 5N	3♂	121
H. e. taurica									1♀					1
H. parva	1N		3N		1N	1♂1N		2N			1♂			10
H. punctata			2♀			1♂		1N			1♂			5
H. sulcata			2♂		1N	2N			1N					6
H. aegyptium	1♂		2♂ 1♀	1♂ 2♀	1♂			1♂		2♀	1♂ 1♀			13
H. excavatum			2♂ 6♀	3♂ 5♀	1♂ 1♀	6♂ 5♀	3♂	2♂ 1♀		9♂ 9♀	35♂ 20♀	2♂ 1♀		111
H. marginatum	62♂ 22♀	4♂, 3♀	162♂ 101♀	7♂ 6♀	20♂ 15♀	9♀	8♂ 6♀	132♂ 62♀	14♂ 7♀	23♂ 13♀	9♂ 11♀	65♂ 22♀	1♂1♀	785
Hyalomma immature	7N	4N	78N 2L	12N	44N	34N 4L	10N	19N	12N	6N 1L	63N	38N	8N	342
I. laguri								1♀						1
I. ricinus			2N			2N					4N	1♀ 1N		10
R. bursa	4♂ 2♀		3♂ 6♀	1♀		3♂ 1♀		3♀		1♀	4♂ 7♀	2♀		37
R. turanicus	6♂ 10♀ 1N		16♂ 18♀ 1N	3♂		1♂		10♂ 5♀		1N	2♀ 1N	12♂ 21♀ 1N		109
Total	140	12	439	40	88	79	28	266	38	66	166	176	13	1551

[a] Central district

Table 2 Ticks infesting humans in Yozgat province and its districts

Tick Species	Akdagmadeni	Bogazlayan	Cayiralan	Kadisehri	Saraykent	Sarikaya	Sorgun	Sefaatli	Total
D. marginatus	9♂ 5♀	5♂	2♂ 1♀	2♂, 1N	2 ♂ 2♀	1♂	26♂ 27 ♀ 4N	1♀	88
H. parva	2♀	3♂			1♀		9♂ 10 ♀		25
H. punctata							1♀		1
H. aegyptium					1♂		1♂		2
H. excavatum	1♀						1♂		2
H. marginatum	88♂ 23♀	1♂ 1♀	2♂	6♂ 10♀	17♂ 7♀	10♂ 5♀	111 ♂ 47♀	3♂ 5♀	336
Hyalomma immature	36N			8N					44
R. annulatus							1♂		1
R. bursa	7♂ 1♀		1♀	3♀	1♂		8♂ 2♀		23
R. turanicus	2♂ 6♀		1 ♂	2♀	2♂ 2♀	2♀	7♂ 9 ♀	1♂ 2♀	36
R. sanguineus							1♀		1
Total	180	10	7	32	35	18	266	12	559

Corum province (Table 1), whereas 10 tick species were identified in Yozgat province (Table 2). The most prevalent ticks infesting humans in both provinces were *Hyalomma marginatum*, *Dermacentor marginatus* and *Rhipicephalus turanicus* sensu lato. *Haemaphysalis erinacei taurica, Haemaphysalis sulcata*, *Ixodes laguri* and *Ixodes ricinus* were only found in the Corum province while *Rhipicephalus annulatus* and *Rhipicephalus sanguineus* sensu lato were only found in the Yozgat province. Additionally, a total of 386 immature *Hyalomma* were found on humans in Corum (335 nymphs, 7 larvae) and Yozgat provinces (44 nymphs). In addition *I. laguri* and *H. e. taurica* was recorded for the first time in Corum province.

Tick infestations on humans were seen in all district (except Bogazkale) of the Corum province, whereas tick infestations on humans in the Yozgat province were seen only in 8 district, namely Akdagmadeni, Bogazliyan, Cayiralan, Kadisehri, Saraykent, Sarikaya, Sorgun, and Sefaatli. The prevalence of tick infestation in Corum province was found highest in Capital district (n = 439), Mecitozu (n = 266), Sungurlu (n = 176), Osmancik (n = 166) and Alaca (n = 140) districts while the prevalence of tick infestation in Yozgat province was found highest in Sorgun (n = 266) and Akdagmadeni (n = 180) districts. Distributions of ticks on humans according to the district are shown in Table 1 (Corum) and Table 2 (Yozgat) for each tick species.

Discussions

Although tick-borne human diseases, especially CCHF, are seen commonly in Corum and Yozgat provinces (Tanir et al. 2009; Kandis et al., 2012), information on ticks infesting humans are very scanty in these provinces. In the present study, a total of 2110 hard ticks were collected from humans in the Corum and Yozgat provinces between June and September 2009. The results obtained in this study showed that at least 14 different hard tick species (12 species from Corum, 10 species from Yozgat) were found feeding on humans in the study area.

The species *H. marginatum* was most prevalent ticks collected on humans, as similarly with other studies (Bursali et al. 2012, 2013; Bakirci et al. 2014). The tick is the main vector of CCHF in Turkey (Tonbak et al. 2006; Vatansever et al. 2007; Tekin et al. 2012). In addition, several tick-borne pathogens such as *Rickettsia aeschlimannii* and *Borrelia burgdorferi* sensu stricto have been isolated from *H. marginatum* in Turkey (Gargili et al. 2012; Orkun et al. 2014). Other encountered hyalommids infesting humans in the both provinces were identified as *Hyalomma aegyptium* and *Hyalomma excavatum*. *H. aegyptium* is a specific parasite of the tortoise, while *H. excavatum* parasitize many kinds of livestock, preferring cattle. There are many reports of human infestations by both species in Turkey (Vatansever et al. 2008; Karaer et al. 2011; Bakirci et al. 2014). *Rickettsia africae* and *R. aeschlimannii* in *H. aegyptium; R. aeschlimannii* and *B. burgdorferi* sensu stricto in *H. excavatum* have been detected in Turkey (Gargili et al. 2012; Orkun et al. 2014). However, there is no sufficient evidence on the vector competence of these tick species in Turkey. Immature *Hyalomma* have been also collected on humans in this study. It is well–known that morphological identification of immature *Hyalomma* is very difficult (Apanaskevich and Horak 2008; Hagman et al. 2014); therefore identifications of these specimens should be confirmed by a molecular approach in further studies.

The genus *Dermacentor* currently consists of 38 species distributed in the Palearctic and Nearctic Regions (Apanaskevich and Bermúdez 2013; Guglielmone et al. 2014;

Apanaskevich and Apanaskevich 2015a, 2015b). Among the member of genus *Dermacentor*, 25 species can feed on humans (Guglielmone et al. 2014; Apanaskevich and Apanaskevich 2015a, 2015b). For a long time, there are many disagreements about the identification of Palearctic *Dermacentor*. Filippova and Plaksina (2005) have emphasized that species identifications of *Dermacentor marginatus* complex are very difficult. Without any molecular study, identification of immature ticks is difficult as species level and their identification are generally identified in genus level. However, Filippova (1997) provide many useful morphological characters for identification of immature *Dermacentor* ticks. Based on Filippova (1997), nymphs of *D. marginatus* can be distinguished from other *Dermacentor* nymphs by a combination of the second palpal segment about half as long again as that of third when viewed ventrally, on the scutum less than 40 short setae, spur of coxa IV is usually shorter than III. Nowadays, genus *Dermacentor* is under revision and, therefore it expects that some changes in the taxonomy and nomenclature of this genus in the near future (Guglielmone et al. 2014).

In the present study, *D. marginatus* was second abundant tick species infesting humans in Corum and Yozgat provinces. *D. marginatus* is typically three-host ticks and occurs widely in West/Southwest Palaearctic region (Estrada-Peña et al. 2004). The tick is an important vector of *Coxiella burnetii, Rickettsia conorii, Rickettsia slovaca* and *Rickettsia sibirica* (Farkas et al. 2013). The immature of *D. marginatus* feed on small mammals and rarely Anura, Aves and Squamata (Farkas et al. 2013; Guglielmone et al. 2014). Several tick-borne pathogens such as *Rickettsia raoultii*, *R. slovaca*, and CCHF have been detected in *D. marginatus* (Albayrak et al. 2010; Gargili et al. 2012; Orkun et al. 2014). Although numerous cases of human infestations by *D. marginatus* have been reported in Turkey (Gargili et al. 2010; Karaer et al. 2011; Bursali et al. 2013; Bakirci et al. 2014), sufficient evidence has not been found about that *D. marginatus* may play a role in transmission of these pathogen.

The genus *Haemaphysalis* is represented 167 species in the world and 56 of them can be infested on humans (Guglielmone et al. 2014). *Haemaphysalis parva* and *Haemaphysalis punctata* are two of very common haemaphysalids ticks infesting humans (Karaer et al. 2011; Bursali et al. 2011). In the present study, *H. parva* and *H. punctata* were collected from both Corum and Yozgat provinces, whereas *H. sulcata* was collected only Corum province. Although several tick-borne pathogens such as *B. burgdorferi* sensu stricto *Rickettsia hoogstraalii*, CCHFV have been detected in *H. parva* (Gunes et al. 2011; Orkun et al. 2014), there is limited information on vectorial capacity of the tick.

Two species belonging to the genus *Ixodes* were only collected on humans only in Corum province in the current study. *I. ricinus* is one of the most common tick species in Turkey (Merdivenci 1969; Bursali et al. 2012). This tick is a vector of many important pathogens that cause diseases in humans including Lyme disease, anaplasmosis and babesiosis (Carpi et al. 2011; Lommano et al. 2012). In Turkey, *B. burgdorferi* sensu lato, *Rickettsia monacensis*, *Rickettsia helvetica* and CCHF virus are some of the tick-borne pathogens reported in *I. ricinus* (Guner et al. 2003; Albayrak et al. 2010; Gargili et al. 2012). On the other hand, information on the distribution of *I. laguri* in Turkey is very scanty. Main hosts of the tick are rodents (Balashov 1997). This tick was formerly found on *Arvicola amphibius* (as *Arvicola terrestris hintoni*), *Spermophilus citellus* (as *Citellus citellus*), *Crocidura* sp., *Microtus* sp., *Meriones tristrami* (as *Meriones blackeri intraponticus*) by Arthur (1957) and Merdivenci (1969) in Turkey. Subsequently, the presence of *I. laguri* on animals and humans were reported in several studies (Bursali et al. 2012, 2015). We believe that the distribution area of *I. laguri* is expected to expand in Turkey with additional investigations.

Rhipicephalus bursa and *R. turanicus* sensu lato were collected on humans in Corum while *R. annulatus, R. bursa, R. turanicus* sensu lato and *R. sanguineus* sensu lato were collected on humans in Yozgat province. *Rhipicephalus sanguineus* complex is composed of at least 12 different species, with probable cryptic species and there are many taxonomic problems in morphological identification of members of *R. sanguineus* complex (Guglielmone et al. 2014; Nava et al. 2015). The type specimen of *R. sanguineus* sensu stricto has been lost and the original description given by Latreille was poor (Dantas-Torres et al. 2013; Guglielmone et al. 2014; Nava et al. 2015). The taxonomic status of *R. sanguineus* sensu stricto is still unclear. Guglielmone et al. (2014) stated that all records (except Gallia) of *R. sanguineus* sensu stricto from around the world are currently speculative. Nava et al. (2015) highlighted that "*R. sanguineus* species group" or "*R. sanguineus* sensu lato" should be used instead of "*R. sanguineus* sensu stricto" until the taxonomic status of this species is clarified. In this study, a female of *R. sanguineus* sensu lato was collected from human only in Yozgat province. This species is associated with several zoonotic diseases, which is one of them Mediterranean Spotted Fever (MSF). Although human infestations by the *R. sanguineus* sensu lato are rarely reported (Bursali et al. 2011, 2013; Bakirci et al. 2014), many MSF cases have been reported in Turkey, especially Thrace region (Kuloglu et al. 2012).

During the study, *R. turanicus* sensu lato were commonly found on humans, particularly in Corum province. There is continuing debate about the taxonomic status of this species. Guglielmone et al. (2014) have emphasized that usage of epithet *turanicus* to any populations (except identified in Filippova 1997) will not be possible until the taxonomic status of this species is clarified. In the present study, we were used key provided by Filippova (1997) for the identification of *R. turanicus*. Nonetheless, we prefer to use of "*R. turanicus* sensu lato" instead of "*R. turanicus* sensu stricto" to avoid conflicting views about this taxon (as proposed by Guglielmone et al. 2014). *R. turanicus* sensu lato can feed on a wide variety of hosts, including hedgehogs, hares, cattle, sheep, goats, and domestic dogs (Walker et al. 2000). Although there are many reports of human infestations by *R. turanicus* sensu lato (Karaer et al. 2011; Bursali et al. 2012; Bakirci et al. 2014), information about its vectorial capacity is very limited.

R. bursa is one of the tick species commonly found on humans in Turkey (Gargili et al. 2010; Bursali et al. 2011; Bakirci et al. 2014; Orkun et al. 2014). The tick is a highly distinctive species; it can be easily identified from densely punctate scutum or conscutum. Several pathogens such as *R. aeschlimannii* and CCHF have been detected in *R. bursa* tick (Gargili et al. 2012; Tekin et al. 2012). According to current data, the role of *R. bursa* in the transmission of these pathogenic agents to humans in Turkey is still unclear. On the other hand, human infestations by *R. annulatus* ticks are very rare (Bursali et al. 2011; Bakirci et al. 2014). *R. annulatus* is a one–host tick and all parasitic stage of the tick mainly feed on cattle, therefore human infestations by the tick are incidental.

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References

Albayrak H, Ozan E, Kurt M (2010) An antigenic investigation of Crimean-Congo hemorrhagic fever virus (CCHFV) in hard ticks from provinces in northern Turkey. Trop Anim Health Prod 42:1323–1325

Apanaskevich MA, Apanaskevich DA (2015a) Description of new *Dermacentor* (Acari: Ixodidae) species from Malaysia and Vietnam. J Med Entomol 52:156–162
Apanaskevich MA, Apanaskevich DA (2015b) Reinstatement of *Dermacentor bellulus* (Acari: Ixodidae) as a valid species previously confused with *D. taiwanensis* and comparison of all parasitic stages. J. Med. Entomol. doi:10.1093/jme/tjv034
Apanaskevich DA, Bermúdez SE (2013) Description of a new *Dermacentor* (Acari: Ixodidae) species, a parasite of wild mammals in Central America. J Med Entomol 50:1190–1201
Apanaskevich DA, Horak IG (2008) The genus *Hyalomma* Koch, 1844: V. re-evaluation of the taxonomic rank of taxa comprising the *H. (Euhyalomma) marginatum* Koch complex of species (Acari: Ixodidae) with redescription of all parasitic stages and notes on biology. Int J Acarol 34:13–42
Arthur DR (1957) Studies on exotic *Ixodes* ticks (Ixodoidea, Ixodidae) from United States navy and army activities. J Parasitol 43:681–994
Bakirci S, Aysul N, Eren H, Unlu AH, Karagenc T (2014) Diversity of ticks biting humans in Aydın province of Turkey. Ank Univ Vet Fak Derg 61:93–98
Balashov YS (1997) Distribution of ixodid ticks (Acarina, Ixodidae) over landscapes within their ranges in Russia. Entomol Rev 77:625–637
Bursali A, Tekin S, Keskin A, Ekici M, Dundar E (2011) Species diversity of ixodid ticks feeding on humans in Amasya, Turkey: seasonal abundance and presence of Crimean-Congo hemorrhagic fever virus. J Med Entomol 48:85–93
Bursali A, Keskin A, Tekin S (2012) A review of the ticks (Acari: Ixodida) of Turkey: species diversity, hosts and geographical distribution. Exp Appl Acarol 57:91–104
Bursali A, Keskin A, Tekin S (2013) Ticks (Acari: Ixodida) infesting humans in the provinces of Kelkit Valley, a Crimean-Congo hemorrhagic fever endemic region in Turkey. Exp Appl Acarol 59:507–515
Bursali A, Keskin A, Şimşek E, Keskin A, Tekin S (2015) A survey of ticks (Acari: Ixodida) infesting some wild animals from Sivas, Turkey. Exp Appl Acarol 66:293–299
Carpi G, Cagnacci F, Wittekindt NE, Zhao F, Qi J, Tomsho LP, Drautz DI, Rizzoli A, Schuster SC (2011) Metagenomic profile of the bacterial communities associated with *Ixodes ricinus* ticks. PLoS One 6:e25604
Dantas-Torres F, Latrofa MS, Annoscia G, Giannelli A, Parisi A, Otranto D (2013) Morphological and genetic diversity of *Rhipicephalus sanguineus* sensu lato from the New and Old Worlds. Parasit Vectors 6:213
Estrada-Peña A, Jongejan F (1999) Ticks feeding on humans: a review of records on human-biting Ixodoidea with special reference to pathogen transmission. Exp Appl Acarol 23:685–715
Estrada-Peña A, Bouattour A, Camicas JL, Walker AR (2004) Ticks of veterinary and medical importance: the mediterranean basin. A guide of identification of species. University of Zaragoza Press, Zaragoza
Estrada-Peña A, Gray JS, Kahl O, Lane RS, Nijhof AM (2013) Research on the ecology of ticks and tick-borne pathogens-methodological principles and caveats. Front Cell Infect Microbiol 3:29
Farkas R, Estrada-Peña A, Jaenson TG, Pascucci I, Madder M (2013) Basic biology and geographical distribution of tick species involved in the transmission of animal pathogens, including zoonoses. In: Salman M, Tarrés-Call J (eds) Ticks and tick-borne diseases: geographical distribution and control strategies in the Euro-Asia region. CAB International, Boston, pp 6–26
Filippova NA (1977) Ixodid ticks of the subfamily Ixodinae-Fauna SSSR. Nauka Publishing House, Moscow **(in Russian)**
Filippova NA (1997) Ixodid ticks of subfamily Amblyomminae. In: Fauna of Russia and neighbouring countries, vol 4, no. 5. Nauka Publishing House, St. Petersburg **(in Russian)**
Filippova NA, Plaksina MA (2005) Some aspects of intraspecific variability of the closely related species of the *Dermacentor marginatus* complex (Acari: Ixodidae) as demonstration of microevolution process. Parazitologiia 39:337–364 **(In Russian)**
Gargili A, Kar S, Yilmazer N, Cerit C, Sonmez G, Sahin F, Alp H, Vatansever Z (2010) Evaluation of ticks biting humans in Thrace Province, Turkey. Kafkas Univ Vet Fak Derg 16(Suppl–A):141–146
Gargili A, Kar S, Yilmazer N, Ergonul O, Vatansever Z (2011) Different abundances of human–biting ticks in two neighboring provinces in Turkey. Kafkas Univ Vet Fak Derg 17(SupplA):93–97
Gargili A, Palomar AM, Midilli K, Portillo A, Kar S, Oteo JA (2012) *Rickettsia* species in ticks removed from humans in Istanbul, Turkey. Vector Borne Zoonotic Dis 12:938–941
Guglielmone AA, Robbins RG, Apanaskevich DA, Petney TN, Estrada-Peña A, Horak IG (2014) The hard ticks of the world. Springer, Dordrecht
Guner ES, Hashimoto N, Takada N, Kaneda K, Imai Y, Masuzawa T (2003) First isolation and characterization of *Borrelia burgdorferi* sensu lato strains from *Ixodes ricinus* ticks in Turkey. J Med Microbiol 52:807–813

Gunes T, Poyraz O, Vatansever Z (2011) Crimean-Congo hemorrhagic Fever virus in ticks collected from humans, livestock, and picnic sites in the hyperendemic region of Turkey. Vector Borne Zoonotic Dis 11:1411–1416

Hagman K, Barboutis C, Ehrenborg C, Fransson T, Jaenson TG, Lindgren PE, Lundkvist A, Nystrom F, Waldenstrom J, Salaneck E (2014) On the potential roles of ticks and migrating birds in the ecology of West Nile virus. Infect Ecol Epidemiol 4:20943

Jongejan F, Uilenberg G (2004) The global importance of ticks. Parasitology 129:S3–S14

Kandis H, Katirci Y, Baltaci D, Saritas A, Kara IH, Geyik MF (2012) Investigation of clinical and laboratory findings of 26 cases with Crimean-Congo hemorrhagic fever. Biomed Res India 23:589–595

Karaer Z, Guven E, Nalbantoglu S, Kar S, Orkun O, Ekdal K, Kocak A, Akcay A (2011) Ticks on humans in Ankara, Turkey. Exp Appl Acarol 54:85–91

Keskin A, Koprulu TK, Bursali A, Ozsemir AC, Erciyas-Yavuz K, Tekin S (2014) First record of *Ixodes arboricola* (Ixodida: Ixodidae) From Turkey with presence of Candidatus Rickettsia vini (Rickettsiales: Rickettsiaceae). J Med Entomol 51:864–867

Kuloglu F, Rolain JM, Akata F, Eroglu C, Celik AD, Parola P (2012) Mediterranean spotted fever in the Trakya region of Turkey. Ticks Tick Borne Dis 3:298–304

Lommano E, Bertaiola L, Dupasquier C, Gern L (2012) Infections and coinfections of questing Ixodes ricinus ticks by emerging zoonotic pathogens in Western Switzerland. Appl Environ Microbiol 78:4606–4612

Marrelli MT, Souza LF, Marques RC, Labruna MB, Matioli SR, Tonon AP, Ribolla PE, Marinotti O, Schumaker TTS (2007) Taxonomic and phylogenetic relationships between neotropical species of ticks from genus *Amblyomma* (Acari: Ixodidae) inferred from second internal transcribed spacer sequences of rDNA. J Med Entomol 44:222–228

Merdivenci A (1969) Türkiye Keneleri Üzerine Araştırmalar. Kurtulmuş Matbaası, Istanbul

Nava S, Estrada-Peña A, Petney T, Beati L, Labruna MB, Szabó MP, Venzal JM, Mastropaolo M, Mangold AJ, Guglielmone AA (2015) The taxonomic status of *Rhipicephalus sanguineus* (Latreille, 1806). Vet Parasitol 208:2–8

Orkun O, Karaer Z, Cakmak A, Nalbantoglu S (2014) Identification of tick-borne pathogens in ticks feeding on humans in Turkey. PLoS Negl Trop Dis 8:e3067

Otranto D, Dantas-Torres F, Giannelli A, Latrofa MS, Cascio A, Cazzin S, Ravagnan S, Montarsi F, Zanzani SA, Manfredi MT, Capelli G (2014) Ticks infesting humans in Italy and associated pathogens. Parasit Vectors 7:328

Tanir G, Tuygun N, Balaban I, Doksoz O (2009) A case of Crimean-Congo hemorrhagic fever with pleural effusion. Jpn J Infect Dis 62:70–72

Tekin S, Bursali A, Mutluay N, Keskin A, Dundar E (2012) Crimean-Congo hemorrhagic fever virus in various ixodid tick species from a highly endemic area. Vet Parasitol 186:546–552

Tonbak S, Aktas M, Altay K, Azkur AK, Kalkan A, Bolat Y, Dumanli N, Ozdarendeli A (2006) Crimean-Congo hemorrhagic fever virus: genetic analysis and tick survey in Turkey. J Clin Microbiol 44:4120–4124

Vatansever Z, Uzun R, Estrada-Peña A, Ergonul O (2007) Crimean-Congo haemorrhagic fever in Turkey. In: Ergonul O, Whitehouse CA (eds) Crimean-Congo hemorrhagic fever: a global perspective. Springer, Dordrecht, pp 59–74

Vatansever Z, Gargili A, Aysul NS, Sengoz G, Estrada-Peña A (2008) Ticks biting humans in the urban area of Istanbul. Parasitol Res 102:551–553

Walker JB, Keirans JE, Horak IG (2000) The genus *Rhipicephalus* (Acari, Ixodidae): a guide to the brown ticks of the world. Cambridge University Press, Cambridge

Yesilyurt M, Kilic S, Cagasar O, Celebi B, Gul S (2011) Two cases of tick-borne tularemia in Yozgat Province, Turkey. Mikrobiyol Bul 45:746–754