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# Ticks (Acari: Ixodida) infesting humans in the provinces of Kelkit Valley, a Crimean-congo hemorrhagic fever endemic region in Turkey

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**Abstract** Ticks are mandatory blood feeding ectoparasites leading transmission of various tick-borne pathogens to human and animals. Since 2002, thousands of human tick bites and numerous Crimean-Congo Hemorrhagic Fever cases have been reported in several provinces in the Kelkit Valley region in Turkey. Despite increased cases of tick bites and tick-borne diseases, no taxonomic information is available about the tick species infesting humans in the region. In the present study, a tick survey on humans was performed to determine the species composition of ticks infesting humans in several provinces of Kelkit Valley. In the survey, 1,460 ticks (721 males, 516 females and 223 nymphs) were collected from tick-infested humans. A total of 19 tick species have been found on humans in the region, including 7 *Hyalomma,* 2 *Argas*, 2 *Haemaphysalis*, 2 *Ixodes*, *Dermacentor* and 3 *Rhipicephalus* species. Infestation of *Dermacentor reticulatus* on humans was documented for the first time in Turkey.

**Keywords** Human · Kelkit Valley · Ticks · Turkey

## Introduction

Ticks are important blood sucking arthropods causing transmission of many pathogens to domestic animals and humans. Ticks are represented by about 896 species belong to 3 families as Ixodidae, Argasidae and Nuttalliellidae in the world (Horak et al. 2002; Guglielmone et al. 2010). In Turkey, the first systematic surveys on ticks infesting domestic animals and wild animals especially small rodents were performed by Oytun

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(1947), Kurtpinar (1954), Hoogstraal (1959), Nemenz (1962, 1967), Merdivenci (1969), Hoffman et al. (1971) and Ozkan (1978). The most detailed taxonomic studies on the fauna and geographic distribution of Turkish ticks was performed by Bursali et al. (2012). According to this recent study, tick fauna of Turkey consists of 8 species of argasid and 38 species of ixodid ticks. In that study, 3 argasid, 27 ixodid species (in our collection), and 2 ixodid species in US National Tick Collection (USNTC) were actually identified based on valid keys for ticks and tick samples in USNTC and the rest compiled from literature.

Recent studies of Bursali et al. (2010, 2011) indicated a wide variety of ticks species collected on humans present in Tokat and Amasya provinces located in the Kelkit Valley region. Since cases of tick bites increased during the last 10 years, it is proposed that not only variety but also the population of ticks increased dramatically in Turkey, especially in the Kelkit Valley region (Bursali 2010, 2011). According to The Republic of Turkey Ministry of Health, 6396 Crimean-Congo Hemorrhagic Fever (CCHF) cases and 322 deaths were recorded from 2002 to 2011 in Turkey (year: CCHF cases/death, 2002: 17/0, 2003: 133/6, 2004: 249/13, 2005: 266/13, 2006: 438/27, 2007: 717/33, 2008: 1,315/63, 2009: 1,318/63, 2010: 868/50, 2011: 1075/54) (Turkey Ministry of Health 2009; Maltezou et al. 2010). In addition to a rich variety of tick species collected humans, numerous fatal cases of tick-borne CCHF have been reported in Turkey, especially in several provinces in the Kelkit Valley region by 2010. Of the 1,743 cases, 72 were dead in the provinces of the Kelkit Valley between 2002 and 2009. However, there is very limited information about diversity, distribution and prevalence of tick-borne diseases in ticks infesting humans and animals in the other provinces of this region. The aim of this study is determination of species composition of tick collected on humans in several provinces of the Kelkit Valley.

## Materials and methods

### Study area

Kelkit Valley is a transitional zone between Central Anatolia and the Middle and East Black Sea regions geographically (Fig. 1). Kelkit Valley starts from the Giresun Mountains and lies in an east–west direction along the Yesilirmak Mountain and Canik mountains which constitute the northern and southern slopes of the valley. The mean altitudes of these regions are between 1,400 and 1,500 m. At the bottom of the valley there is a clear decrease in height in an east–west direction. The altitude is about 650 m in Koyulhisar, 450 m in Resadiye, 350 m in Niksar and 280 m in Erbaa. It is also a transitional zone between the Euro-Siberian and Irano-Turanian phytogeographic regions. Such transition zones have interesting properties, due to the mixing of oceanic and continental climates (Karaer et al. 1999). Kelkit Valley is very suitable for tick growth because of suitable vegetation and climate. The current study was performed in the Bayburt, Giresun, Gumushane and Sivas provinces located in the Kelkit Valley (Fig. 1).

### Collection and morphological identification of ticks

A total of 1,460 (721 males, 516 females 223 nymphs) ticks were collected from tick infested humans between 2008 and 2009. Tick collection was performed in the major hospitals and local health clinics of these provinces and ticks removed from humans by doctors, nurses, or health technicians under aseptic conditions, stored in 70 % alcohol. Tick samples were deposited to the Acarology laboratory in Gaziosmanpasa University,

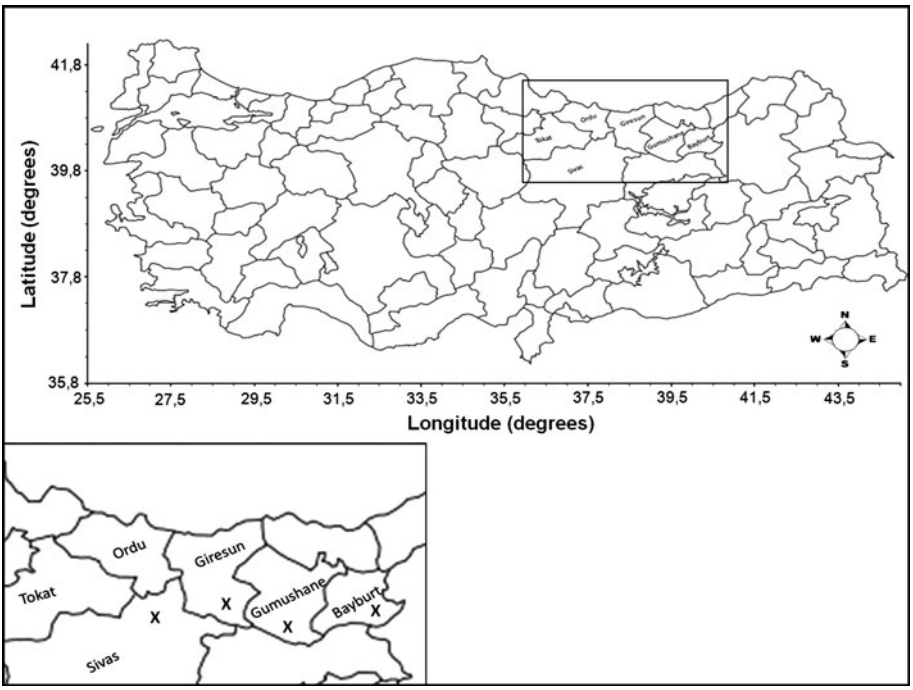


**Fig. 1** Map of the study area, the Kelkit Valley Region

Department of Biology for taxonomic identification. Tick samples were identified to species using the keys of Pomerantzev (1950), Merdivenci (1969), Ozkan (1978), Filippova (1977, 1997), Walker et al. (2000), Estrada-Peña et al. (2004) and Apanaskevich and Horak (2008). The tick species identified in this study were listed according to the list of valid tick names reported by Horak et al. (2002) and Guglielmone et al. (2010). The nymphs were not examined to avoid misidentification because of damaged body parts.

## Results

### Species diversity of ticks infesting on humans in Kelkit Valley

Species diversity of ticks infesting on humans in Kelkit Valley was summarized in Table 1. A total of 1,460 (721 males, 516 females 223 nymphs) ticks were collected from tick infested humans between 2008 and 2009 in Kelkit Valley. Of 1,460 ticks, 1,237 adult ticks were identified as *Hyalomma* spp. (n = 695, 56.18 %), *Rhipicephalus* spp. (n = 223, 18.0 %), *Haemaphysalis* spp. (n = 140, 11.3 %), *Dermacentor* spp. (n = 168, 13.6 %), *Ixodes* spp. (n = 9, 0.73 %), and *Argas* spp. (n = 2, 0.16 %). Nineteen species have been collected in the four provinces (Bayburt, Gumushane, Giresun, and Sivas). *Hyalomma marginatum* (n = 609, 49.2 %), *Rhipicephalus bursa* (n = 183, 14.8 %), *Haemaphysalis parva* (n = 131, 10.6 %) and *Dermacentor marginatus* (n = 135, 11.91 %) were the most common ticks species. *Argas reflexus*, *Argas* sp., *Hyalomma anatolicum*, and *Ixodes redikorzevi* were the most seldom tick species infesting humans in the region. There was

**Table 1** Diversity and relative abundance of tick species infesting humans in the Kelkit Valley Region

| Tick species | Provinces | | | | | | | | Total | (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Bayburt | | Gumushane | | Giresun | | Sivas | | | |
| *A. reflexus* (Fabricius) | | | | | | | | 1♀ | 1 | 0.08 |
| *Argas* sp. | | | | | | | | 1♀ | 1 | 0.08 |
| *D. reticulatus* Fabricius | 5♂ | 6♀ | | | | | | | 11 | 0.89 |
| *D. marginatus* (Sulzer) | 13♂ | 18♀ | 18♂ | 5♀ | | | 44♂ | 37♀ | 135 | 11.9 |
| *D. niveus* Neumann | 10♂ | 1♀ | 3♂ | 2♀ | | | 5♂ | 1♀ | 22 | 1.78 |
| *H. punctata* Canestrini & Fanzago | | | | 3♀ | | | | 6♀ | 9 | 0.73 |
| *H. parva* (Neumann) | 6♂ | 6♀ | 21♂ | 50♀ | | | 22♂ | 26♀ | 131 | 10.6 |
| *H. aegyptium* (Linnaeus) | | | | | | 1♀ | 4♂ | | 5 | 0.4 |
| *H. anatolicum* Koch | | | | | | | 1♂ | | 1 | 0.08 |
| *H. excavatum* Koch | | | | | | | 2♂ | 1♀ | 3 | 0.24 |
| *H. impeltatum* Schulze & Schlottke | | | 2♂ | | | | | | 2 | 0.16 |
| *H. marginatum* Koch | 6♂ | 3♀ | 106♂ | 49♀ | 4♂ | 6♀ | 285♂ | 150♀ | 609 | 49.2 |
| *H. rufipes* Koch | 1♂ | 1♀ | | | | | | | 2 | 0.16 |
| *H. turanicum* Pomerantzev | 1♂ | | 17♂ | 3♀ | 2♂ | | 25♂ | 25♀ | 73 | 5.9 |
| *I. redikorzevi* Olenev | | | | | | | 1♀ | | 1 | 0.08 |
| *I. ricinus* (Linnaeus) | | | | 8♀ | | | | | 8 | 0.65 |
| *R. bursa* Canestrini & Fanzago | | | 14♂ | 2♀ | 18♂ | 10♀ | 69♂ | 70♀ | 183 | 14.8 |
| *R. sanguineus* (Latreille) | | | 1♂ | | | | 3♂ | 4♀ | 8 | 0.65 |
| *R. turanicus* Pomerantzev | | | 1♂ | | | | 14♂ | 17♀ | 32 | 2.59 |
| Total | 42♂ | 35♀ | 183♂ | 122♀ | 24♂ | 17♀ | 475♂ | 339♀ | 1,237 | |

only one specimen (n = 1, 0.08 %) of *Argas* sp., *A. reflexus*, *H. anatolicum*, and *I. redikorzevi*. In addition, presence and human infestation of *Dermacentor reticulatus* in Turkey were reported for the first time in the present study.

### Geographical distribution of tick species infesting human in Kelkit Valley

Sample collection was conducted between 2008 and 2009 in four different provinces (Bayburt, Gumushane, Giresun, and Sivas) of the Kelkit Valley in Turkey (Fig. 1). The distribution of the ticks in each region was shown in Table 1. Of 1,237 ticks, 814 (65.8 %) ticks were from Sivas, 305 (24.7 %) from Gumushane, 77 (6.2 %) from Bayburt, and 41 (3.31 %) from Giresun.

As shown in Table 1, *Hyalomma* spp. and *Rhipicephalus* spp. were abundant in all provinces, whereas *Argas* spp. were very low in numbers and found in Sivas province only. *Dermacentor* spp. were the most common ticks in Bayburt. *D. reticulatus* was found in Bayburt province only. *Haemaphysalis* spp. were collected from all geographic regions except Gumushane province.

## Discussion

Ticks play an important role in the transmission of numerous disease agents effecting humans (Bursali et al. 2011; Tekin et al. 2012). Recently, both tick bite cases and tick-borne diseases in humans increased in several provinces in Turkey, especially in the provinces of Kelkit Valley (Bursali et al. 2011). Therefore, we investigated species infesting on humans in Kelkit valley region. In the present study, a total of 1,460 ticks were collected from tick infested humans between 2008 and 2009 in the Kelkit Valley. More than 80 % of the 1,460 specimens were adults (84.72 %), which were identified as *Argas* sp., *A. reflexus*, *D. reticulatus*, *D. marginatus*, *Dermacentor niveus*, *Haemaphysalis punctata*, *H. parva*, *Hyalomma aegyptium*, *H. anatolicum*, *Hyalomma excavatum*, *Hyalomma impeltatum*, *H. marginatum*, *H. rufipes*, *Hyalomma turanicum*, *I. redikorzevi*, *Ixodes ricinus*, *R. bursa*, *Rhipicephalus sanguineus*, and *Rhipicephalus turanicus*. *H. marginatum* (n = 609, 49.2 %), *R. bursa* (n = 183, 14.8 %), *H. parva* (n = 131, 10.6 %) and *D. marginatus* (n = 135, 11.9 %) were the most prevalent species in the area. It can be said that tick species infesting human may not be reliable for determination of species variety of ticks if tick infestation occurs accidentally on humans and limited to several species only, however the situation is very different in the study area where tick infestation on humans is over thousands and therefore it can't be said that this level of high tick infestation with a wide variety of species is accidental.

According to early reports, the members of genus *Hyalomma* may infest humans and be responsible for the transmission of several tick-borne diseases in Turkey (Vatansever et al. 2008; Bursali et al. 2010, 2011; Gargili et al. 2011). *H. marginatum* was the most common tick species infesting human in the region as we reported their presence in the other provinces of Kelkit Valley, Amasya and Tokat (Bursali et al. 2010, 2011). Since we detected CCHF in several *H. marginatum* species from Kelkit and Sivas, we suggested that *H. marginatum* may be associated with major tick-borne diseases in the region. To date, *H. rufipes* was known as a rare species and restricted in East Anatolia, however recent observations proved the presence of this species in other parts of Turkey such as Aegean, Black Sea and Marmara Regions (Kar et al. 2009; Bursali et al. 2011, 2012; Bakirci et al. 2011). In Turkey, the first human infestation by *H. rufipes* was detected by Bursali et al.

(2011) in Amasya province. Recently, human infestation by *H. rufipes* was recorded in Tokat and Ordu provinces in Turkey (unpublished data). *H. aegyptium* known as a parasite of tortoises in the Mediterranean region and the Middle East (Hoogstraal and Kaiser 1960), but this ticks were unexpectedly found on humans in Turkey (Vatansever et al. 2008; Bursali et al. 2011; Gargili et al. 2010, 2011). Since, CCHFV was found in a *H. aegyptium* sample collected from a hedgehog (*Erinaceus concolor*) in the Tokat province of Kelkit Valley, it may also contribute to transmission of CCHFV to humans (Ekici et al. 2012).

*I. ricinus* is widespread in Europe and has a wide host range. It is distributed throughout the Turkey, especially in the northern provinces. It has great medical and veterinary importance because of being a vector of several disease agents such as *Borrelia* spp., *Rickettsia* spp., Tick-borne encephalitis virus (TBEV), (Estrada-Peña and Jongejan 1999) and CCHFV (Estrada-Peña and Jongejan 1999; Tekin et al. 2012). In addition, the presence of CCHFV in *I. ricinus* ticks has been shown (Albayrak et al. 2010). Since *I. ricinus* is the most prevalent tick species in the provinces of Black Sea Region, it may play major role in the emergence of future CCHF cases in this region. Records of *I. redikorzevi* attacking human were given by some authors in several regions in the world (Feldman-Muhsam 1986; Bursali et al. 2011). There are some concerns about determinations of *I. redikorzevi* and *I. acuminatus.* Kolonin (2009) considered that *I. redikorzevi* is a synonym of *I. acuminatus*, as did Pérez-Eid (2007), but, to date, no comprehensive taxonomic study has been done on the two species. These species are obviously very similar and difficult to identify. Immature stages of both species have a 2/2 dental formula (and they are thus easily separated from *I. ricinus* and others) but *I. acuminatus* would have long alloscutal setae, while *I. redikorzevi* would have as long as those of scutum (Dr. Agustin Estrada-Peña, personal communication). We use Filippova (1977) for the identification of these ticks. Thus, up to now both names are considered preliminary valid (Guglielmone et al. 2010) and therefore we should used these valid names until a recent taxonomic study being performed. *I. redikorzevi* may cause toxicosis (Kasis et al. 1997), and transmit the Hazara virus (Begum et al. 1970) and *Francisella tularensis* (Kolonin 2009) in humans. Recently, *Rickettsia japonica* was reported from *I. redikorzevi* collected from a human in the Tokat province in Turkey (Koprulu et al. 2012), indicating that they may contribute to tick-borne diseases in Kelkit Valley Region.

*Dermacentor* species were less prevalent in the region, appeared especially in the fall and represented by three species; *D. reticulatus*, *D. marginatus*, *D. niveus*. Much confusion has existed regarding the identity of some species of the genus *Dermacentor*, especially *D. niveus*, *D. marginatus*, *D. ushakovae*. The taxonomic status of the these taxa are strongly doubted. *D. niveus* was accepted as a synonym of *D. daghestanicus* by Kolonin (2009), but, in fact, *D. daghestanicus* is a junior synonym of *D. niveus* (Guglielmone et al. 2009). Estrada-Peña and Estrada-Peña (1991) checked a part of the syntype series of *D. niveus* and concluding that this species is conspecific with *D. marginatus*. However, Guglielmone et al. (2010) has been emphasized that comparative studies of *D. marginatus*, *D. niveus* and *D. ushakovae* appears to be needed to further demonstrate the validity of these taxa. Therefore, these taxa are considered provisionally valid while awaiting the results of this comparison. For the identification we would use Filippova (1997). Based on their morphology, these species can be distinguished from other species by a combination of characters are given by Filippova (1997). The presence of *D. reticulatus* was documented in earlier reports by Oytun (1947) and Sayin et al. (1982) in the Central Anatolia. In the present study, this species was collected from human for the first time in Bayburt province. *D. reticulatus* can easily be distinguished from that of other *Dermacentor* species by 2nd palpal segment has a caudally directed spur on its posterio-dorsal margin (Pomerantzev

1950). *Dermacentor* species have medical and veterinary importance as other species because of being a vector of several disease agents such as *Borrelia* spp. and *Rickettsia* spp. (Estrada-Peña and Jongejan 1999). Since *Rickestsia* species were detected in many *Dermacentor* species collected from humans in the Kelkit Valley, these species may be associated with tick borne Rickettsial diseases in the region (Unpublished study).

The one hundred sixty-six *Haemaphysalis* species are known in the world (Guglielmone et al. 2010). They generally infest animals, however human infestation of *Haemaphysalis* species has been reported (Estrada-Peña and Jongejan 1999). In Turkey, six species of *Haemaphysalis* ticks were found on humans (Bursali et al. 2010, 2011; Gargili et al. 2011). Numerous samples of *H. parva* and *H. concinna* were found on humans in this study. Members of this genus can play an important role for the transmission of several disease agents such as CCHFV (Bursali et al. 2011; Tekin et al. 2012), TBEV and Kyasanur forest disease virus (Estrada-Peña and Jongejan 1999). Detection of CCHFV in *H. concinna* (Tekin et al. 2012) and *H. parva* (Gunes et al. 2011) may support their role in CCHFV transmission in Turkey.

Approximately 12 argasid tick species frequently bites humans who intrude into tick infested caves and burrows (Estrada-Peña and Jongejan 1999). *A. reflexus*, known as pigeon ticks, can be found on humans, especially during the eradication of pigeons from buildings. It is reported that these ticks appear to seek a new host on curtains and windows when pigeons are removed from the attics of old houses (Estrada-Peña and Jongejan 1999). Although argasid ticks are common and transmit several diseases to animals and humans (Estrada-Peña and Jongejan 1999), investigations on argasid ticks are very limited in Turkey. Human infestation by argasid ticks in Turkey were first reported by Vogel (1927). As we reported in the present study, human infestation by *A. reflexus* (Kurtpinar 1957, Keskin et al. 2010) was previously documented in Turkey. Recently, Gargili et al. (2011) reported a nymph of *Otobius megnini* from a human in Turkey. Another *Argas* sp. reported in this study was a very interesting soft tick, with an inverted heart-shape. Since we have only one sample and it's unusual shape, we did not described it to avoid misidentification. It is very hard to see *Argas* species on the host because adults of this species generally bite for a short time at night time and leave the host. However it is very well known that these ticks can attach to humans and cause very painful bites and irritation, therefore some people may notice them and applied to the health centers.

The results of the present study have improved our knowledge about the prevalence of tick species and their fauna in the Kelkit valley region. The information obtained from this study may lead designing and application of novel strategies for the control of ticks and tick-borne diseases of animals and humans in the region.

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