

Ixodid ticks (Acari: Ixodidae) infesting humans in Tokat Province of Turkey: species diversity and seasonal activity

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ABSTRACT: Ixodid ticks (Acari: Ixodidae) are the major vectors of pathogens threatening animal and human health. Tokat Province, Turkey, is a suitable habitat for extended tick activity with its moderate climate and vegetation. In the present study, we surveyed humans visiting health centers to determine the species diversity, geographical distribution, and seasonal activity of ixodid ticks infesting them. Out of 5,999 adult ticks collected from humans from April to September, 2008, 800 ticks were identified to species, while the remaining were identified to genus according to their distinct morphological characteristics. *Hyalomma marginatum*, *Hyalomma detritum*, *Rhipicephalus bursa*, *Rhipicephalus (Boophilus) annulatus*, *Haemaphysalis punctata*, *Dermacentor marginatus*, and *Ixodes laguri* were the most prevalent tick species among 24 ixodid tick species infesting humans in the region. One of these tick species, *Hyalomma isacii* was identified as a new record for the ixodid tick fauna of Turkey. *Hyalomma* species were the most abundant in summer, while *Dermacentor* and *Ixodes* species displayed the lowest frequency. *Hyalomma aegyptium* infestation was very common on humans in the province. Results indicated that a variety of ixodid tick species infest humans depending on the season in the target area. It is possible that a variety of ixodid tick species may contribute to the spread of tick-borne diseases such as Crimean-Congo haemorrhagic fever virus (CCHFV), which is endemic in the region. *Journal of Vector Ecology* 35 (1): 180-186. 2010.

Keyword Index: Ixodidae, tick, fauna, human, Tokat, Turkey.

INTRODUCTION

Earlier studies by Hoogstraal (1959), Merdivenci (1969), Kurtpinar (1954), and Erman et al. (2007) established that the ixodid tick fauna of Turkey consisted of 44 species from seven genera (formerly 37 species from six genera according to the world valid tick names reported by Horak et al. (2002), Barker and Murrel (2004) and Guglielmone et al. (2009). The information on tick fauna in earlier reports was based primarily on domestic animals. In spite of a high diversity of animal species, a large domestic animal population, seasonal climate differences among different geographical regions, and rich vegetation, there is very limited information about ixodid ticks infesting humans and animals and their seasonal distribution in Turkey. Therefore, we suspected that there are numerous unidentified tick species infesting humans and animals in the region, as we recently identified *Hyalomma isacii* as a new record for the tick fauna of Tokat and *Hyalomma franchini* and *Ixodes persulcatus* for the tick fauna of Amasya Province of Turkey (Bursali et al., unpublished data).

The moderate climate, year-long vegetation, and abundant wildlife of Tokat Province provide suitable habitats for ixodid ticks. As a major vector of many tick-borne diseases, ixodid ticks are important arthropods for the transmission of the pathogen causing Crimean-Congo Haemorrhagic Fever Virus (CCHFV) (Whitehouse 2004) which caused many fatalities between 2002 and 2007 in Turkey (Ergonul 2006, Yilmaz et al. 2009). In addition, the presence of CCHFV has been detected in several ixodid tick

species in our recent molecular survey in Tokat Province, including *Hyalomma marginatum*, *Hyalomma aegyptium*, and *Rhipicephalus bursa* (Tekin et al. 2009).

Even though the ticks of the region have a great potential for the transmission of tick-borne diseases, to date there is no study on the ixodid ticks infesting humans in any province of Turkey. In the present study, we surveyed humans from April to September, 2008, for ticks to determine the species diversity, geographical distribution, and seasonal activity of ixodid ticks infesting humans in this province.

MATERIALS AND METHODS

Study area

Tokat Province is located in the central Black Sea region, which is a transitional zone between the east Black Sea and central Anatolia regions with geographical coordinates of 40° 19' north and 36° 43' east. The current study was performed in the ten districts (Tokat capital, Almus, Turhal, Pazar, Zile, Artova, Niksar, Resadiye, Sulusaray, and Yesilyurt) of Tokat Province (Figure 1). Altitudes within the districts range between 188-2,200 m. The climate is Mediterranean at low altitudes and becomes oceanic at high altitudes of the province. Forests, degraded forests, and macchia are among the vegetation types (Karaer et al. 1999). High plateaus are covered with pastures interspersed with forests and degraded forests.

Cattle and sheep are the main domestic stock, while goats are limited to some districts of the province. In



Figure 1. Map of Turkey showing geographical location of Tokat Province, together with the sampling localities (*).

some districts, cattles are kept within enclosed pastures. Rotation of the entire herd through different pasture plots dispersed in forest forms and macchia is a common management method. Wild boars, rabbits, hedgehogs, and foxes are very abundant throughout the province, mostly in transition areas between forests and farmlands. In addition, small rodents and reptiles, which are major hosts for ticks, are also abundant wild animals in the province.

Collection and morphological identification of ixodid ticks

A total of 6,500 ticks (5,999 adults, 482 nymphs, and 19 larvae) was collected from 5,908 tick infested humans. Only 5,999 adult ticks collected from 5,455 humans were used in the study. Tick collection was performed in the major hospitals and local health clinics of Tokat Province by doctors, nurses, or health technicians under aseptic conditions, stored in 70% alcohol, and sent to our acarology laboratory for taxonomic identification. Out of 5,999 ticks collected, 800 were identified to species, with the remainder to genus only (Table 1), using identification keys or tick lists from Nuttall and Warburton (1911, 1915), Krantz (1940), Feldman-Muhsam (1954), Kurtpinar (1954), Hoogstraal (1959), Kaiser and Hoogstraal (1964), Merdivenci (1969). The names of the tick species identified in this study were listed according to the list of valid tick names reported by Horak et al. (2002), Barker and Murrel (2004), and Guglielmone et al. (2009).

RESULTS

Species diversity of ixodid ticks infesting humans in Tokat Province

Ixodid ticks infesting humans were identified from 800 samples. As shown in Table 1, a total of 24 ixodid tick species from five genera was found to infest humans in Tokat Province. *Hyalomma marginatum*, *Hyalomma detritum*, *Rhipicephalus bursa*, *Rhipicephalus (Boophilus) annulatus*, *Haemaphysalis punctata*, *Dermacentor marginatus*, and *Ixodes laguri* were the most prevalent ixodid tick species

Table 1. Ixodid tick species infesting humans in Tokat, Turkey.

Genus	Species
<i>Hyalomma</i>	<i>H. aegyptium</i> (Linnaeus, 1758)
	<i>H. anatolicum</i> Koch, 1844
	<i>H. dromedarii</i> Koch, 1844
	<i>H. detritum</i> Schultze, 1919
	<i>H. marginatum</i> Koch, 1844
	<i>H. turanicum</i> Pomerantzev, 1946
	<i>H. isaaci</i> Sharif, 1928*
<i>Rhipicephalus</i>	<i>R. bursa</i> Canestrini & Fangazo, 1878
	<i>R. sanguineus</i> (Latreille, 1806)
	<i>R. turanicus</i> Pomerantzev, 1936
	<i>R. (Boophilus) annulatus</i> (Say, 1821) <i>Rhipicephalus</i> sp.
<i>Haemaphysalis</i>	<i>H. sulcata</i> Canestrini & Fangazo, 1878
	<i>H. concinna</i> Koch, 1844
	<i>H. inermis</i> Birula, 1895
	<i>H. erinacei</i> Pavesi, 1884
	<i>H. parva</i> Neumann, 1897
	<i>H. punctata</i> Canestrini & Fangazo, 1878
<i>Dermacentor</i>	<i>D. daghestanicus</i> Olenev, 1928
	<i>D. niveus</i> Neumann, 1897
	<i>D. marginatus</i> (Sulzer, 1776)
<i>Ixodes</i>	<i>I. laguri</i> Olenev, 1929
	<i>I. redikorzevi</i> Olenev, 1927
	<i>I. ricinus</i> (Linnaeus, 1758)

*New species for Turkey.

infesting humans in the province. Out of 24 species, *Hyalomma isacii* was a new record for the ixodid tick fauna of Turkey (Table 1).

Relative abundance and distribution of ixodid ticks on humans in Tokat Province

A total of 4,073 *Hyalomma*, 992 *Rhipicephalus* (46 *R. (Boophilus)*), 665 *Haemaphysalis*, 194 *Dermacentor*, and 75 *Ixodes* ticks was collected from humans (Table 2). *Hyalomma* ticks rank first in abundance, comprising about 68% of the total ticks captured. The relative abundance of other ixodid tick species was 16% for *Rhipicephalus* (0.8% *R. (Boophilus)*), 11% for *Haemaphysalis*, 3% for *Dermacentor*, and 1% for *Ixodes* in the province (Table 2). The relative abundance of ticks was more than 18% in Tokat city and Zile districts, while it was 12.8% in Turhal, 10.8% in Niksar, and less than 10% in the other districts.

As shown in Table 2, *Hyalomma*, *Rhipicephalus*, *Haemaphysalis*, and *Dermacentor* species were found on humans from all districts, whereas *Ixodes* species were very low in numbers and found especially in Niksar, Tokat city, Pazar, Turhal, and Zile districts, which have a moderate climate with high humidity. *Hyalomma* species were the

Table 2. Numbers and relative abundance of ixodid ticks in the districts of Tokat Province.

DISTRICTS	Genus										TOTAL	%
	<i>Hyalomma</i>	%	<i>Rhipicephalus</i>	%	<i>Haemaphysalis</i>	%	<i>Dermacentor</i>	%	<i>Ixodes</i>	%		
TOKAT CITY	657	16.13	292	30.87	102	15.34	38	19.49	12	16	1,101	18.35
ALMUS	358	8.79	12	1.27	36	5.41	3	1.54	0	0	409	6.82
ARTOVA	311	7.64	49	5.18	60	9.02	27	13.85	0	0	447	7.45
NIKSAR	473	11.61	89	9.41	34	5.11	20	10.26	33	44	649	10.82
PAZAR	327	8.03	39	4.12	47	7.07	4	2.05	10	13.33	427	7.12
RESADIYE	361	8.86	28	2.96	83	12.48	23	11.79	3	4	498	8.3
SULUSARAY	127	3.12	57	6.03	31	4.66	10	5.13	2	2.67	227	3.78
TURHAL	546	13.41	160	16.91	45	6.77	10	5.13	8	10.67	769	12.82
YESILYURT	248	6.09	11	1.16	49	7.37	7	3.59	0	0	315	5.25
ZILE	665	16.33	255	26.96	178	26.77	52	26.67	7	9.33	1,157	19.29
Total	4,073	67.89	992	16.54	665	11.09	194	3.23	75	1.25	5,999	100

Table 3. Numbers and monthly relative abundance of ixodid ticks in districts of Tokat Province.

Districts	Months														
	April	May	June	July	August	September	Total	April	May	June	July	August	September	Total	%
TOKAT CITY	18	162	435	296	68	122	1,101	7.63	14.05	21.56	19.58	9.84	122	1,101	18.35
ALMUS	0	81	152	112	49	15	409	0	7.03	7.53	7.41	7.09	15	409	6.82
ARTOVA	52	49	109	152	57	28	447	22.03	4.25	5.4	10.05	8.25	28	447	7.45
NIKSAR	0	127	236	69	166	51	649	0	11.01	11.69	4.56	24.02	51	649	10.82
PAZAR	0	150	188	53	28	8	427	0	13.01	9.32	3.51	4.05	8	427	7.12
RESADIYE	11	125	133	126	63	40	498	4.66	10.84	6.59	8.33	9.12	40	498	8.3
SUIUSARAY	32	42	68	57	28	0	227	13.56	3.64	3.37	3.77	4.05	0	227	3.78
TURHAL	27	137	323	144	81	57	769	11.44	11.88	16.01	9.52	11.72	57	769	12.82
YESILYURT	4	125	0	186	0	0	315	1.69	10.84	0	12.3	0	0	315	5.25
ZILE	92	155	374	317	151	68	1,157	38.98	13.44	18.33	20.97	21.85	68	1,157	19.29
TOTAL/(%)	236	1,153	2,018	1,512	691	389	5,999	3.93	19.22	33.64	25.2	11.52	389	5,999	100

most prevalent species in all districts, while *Rhipicephalus* species were the second dominant species in Tokat city, Zile, Turhal, Niksar, and Sulusaray (Table 2). In Resadiye, Artova, Yesilyurt, Pazar, and Almus, *Haemaphysalis* species were the second prevalent species. *Ixodes* species were more prevalent than *Dermacentor* species only in Niksar and Pazar districts.

Seasonal activity of ixodid ticks infesting humans

The seasonal activity of ixodid ticks in Tokat Province was determined based on their relative abundance (districts vs months and species vs months) as summarized in Tables 3 and 4. More than 33% and 25% of the total ticks were collected in June and July 2008, while only 3.9 % and 6.5% of the total ticks were collected in April and September, respectively (Table 3), indicating higher tick activity in summer and lower activity in the spring and autumn. Tick activity was higher in Artova and Zile in April, Tokat city and Zile in June and July, Niksar and Zile in August, and Tokat city and Zile in September (Table 3.).

The activity of *Hyalomma* ticks begins around April, increases between June and August, and declines in September (Table 4). *Hyalomma* species, especially *H. marginatum*, *H. turanicum*, *H. detritum*, and *H. isacii*, were found on humans from all districts, especially in the summer. Six percent of the total ticks collected in April were *Rhipicephalus*, with 17%, 29%, 18%, and 8% in June, July, August, and September, respectively. The relative abundance of *Haemaphysalis* ticks gradually declined from 57% to 1% between April and August and peaked at 32% in September, whereas the activity of *Dermacentor* ticks was low from April through the end of the August and doubled in September (Table 4). Numbers of the *Ixodes* ticks were always low from May to August.

DISCUSSION

In previous tick surveys, which usually focused on ticks of animals and tick lists, the ixodid tick fauna of Turkey was represented by 44 species from seven genera (Merdivenci 1969, Ozkan et al. 1988, Erman et al. 2007). There are several detailed reports on ticks of domestic and wild animals (Kurtpinar 1954, El-Metenewy and Zayed 1992, Sayin et al. 1997, Yukari and Umar 2002, Tuncer et al. 2004, Mamak et al. 2006). To date, there is very limited information about ticks infesting humans, even though thousands of people are infested by ticks annually in many provinces of Turkey. Vatansever et al. (2008) reported ticks biting humans in a urban area in western Turkey, while we found 27 ixodid tick species infesting humans in Amasya Province, which is a neighboring province located in the southwest of Tokat (unpublished data). These reports indicate a greater tick infestation on humans in recent years in different provinces of Turkey.

Results of the present study showed that at least 24 ixodid tick species from five genera were infesting humans in Tokat Province in 2008. The diversity of ixodid ticks infesting humans is greater than for any other animal

Table 4. Seasonal activity of ixodid tick species infested in humans in Tokat Province. Seasonal activity of ticks was determined based on relative abundance of ticks in Spring (April and May), Summer (June, July, and August), and Fall (September), 2008.

Month	Genus	%
April	<i>Haemaphysalis</i>	56.8
	<i>Hyalomma</i>	30.9
	<i>Dermacentor</i>	6.4
	<i>Rhipicephalus</i>	5.9
May	<i>Hyalomma</i>	61.8
	<i>Haemaphysalis</i>	28.7
	<i>Rhipicephalus</i>	3.8
	<i>Dermacentor</i>	3.0
June	<i>Ixodes</i>	2.7
	<i>Hyalomma</i>	79.4
	<i>Rhipicephalus</i>	16.8
	<i>Haemaphysalis</i>	2.4
July	<i>Dermacentor</i>	0.7
	<i>Ixodes</i>	0.7
	<i>Hyalomma</i>	68.6
	<i>Rhipicephalus</i>	29.0
August	<i>Haemaphysalis</i>	1.1
	<i>Dermacentor</i>	0.8
	<i>Ixodes</i>	0.5
	<i>Hyalomma</i>	73.0
September	<i>Rhipicephalus</i>	18.1
	<i>Dermacentor</i>	5.2
	<i>Ixodes</i>	2.3
	<i>Haemaphysalis</i>	1.4
October	<i>Hyalomma</i>	37
	<i>Haemaphysalis</i>	32.4
	<i>Dermacentor</i>	21.1
	<i>Rhipicephalus</i>	8.2
November	<i>Ixodes</i>	1.3

species reported in Turkey (El-Metenewy and Zayed 1992, Yukari and Umar 2002, Tuncer et al. 2004, Mamak et al. 2006). *Hyalomma marginatum*, *H. detritum*, *Rhipicephalus bursa*, *R. (Boophilus) annulatus*, *Haemaphysalis punctata*, *Dermacentor marginatus*, and *Ixodes laguri* were the most prevalent tick species infesting humans in the region. According to our results, the prevalence of tick infestation on humans was very high in the region. *Hyalomma isacii* was identified as a new record for the ixodid tick fauna of Turkey (Table 1). Interestingly, *Hyalomma aegyptium* which is specific for tortoises, was found on humans in several districts, suggesting accidental infestation of humans is

possible. Since more than 4,000 *Hyalomma* ticks infested humans in the region, accidental infestation of humans may not be valid for all species and several species might actually prefer humans as a host. The higher abundance of turtles in the province and detection of CCHFV in *Hyalomma aegyptium* (Tekin et al. 2009) indicate the various tick species might be associated with transmission of CCHFV to humans. Therefore, it is suggested that the management of ticks infesting humans and control of wild animals should be considered for efficient protection of people from tick-borne diseases.

As summarized in Table 1, *Hyalomma* (68%) and *Rhipicephalus* (16%) ticks ranked first and second in relative abundance. Results showed that more than 18% of the total ticks collected were from people residing in Tokat city and Zile districts, while the relative abundance of ticks in other districts was less than 13%. These results were parallel to characteristics of the districts where low altitude grasslands, rich woody vegetation, high variety and number of wild animals and livestock, moderate temperatures, and high humidity are the main geographical and climatic characteristics of Zile, Tokat city, and Turhal, whereas Niksar and Resadiye districts have high altitude plateaus covered with forests, degraded forests, and grasslands, and semi-arid cool and semi-arid cold bioclimates (Karaer et al. 1999).

The cases of CCHF between 2002 and 2007 in Tokat Province (Yilmaz et al. 2009) and the detection of CCHFV in ixodid tick pools and in ticks support a correlation between relative abundance of ticks and numbers of CCHF cases in the province. To date, there is very limited information about the presence of other tick-borne pathogens in ticks and in humans in Tokat Province. Our results also showed that the abundance and diversity of ticks were associated with bioclimatic conditions of the districts (Tables 3 and 4).

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