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# Distribution of hard tick species in Ankara, Turkey

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**Abstract:** A systematic study has been carried out on hard ticks from Ankara Province, Turkey. Between April 2010 and July 2012, 1800 tick specimens belonging to 9 species were identified at 31 locations in 9 districts. Tick species are listed as follows: *Rhipicephalus sanguineus* group (43.44%), *Rhipicephalus bursa* (36.67%), *Hyalomma marginatum* (8.83%), *Haemaphysalis parva* (6%), *Hyalomma aegyptium* (2.39%), *Hyalomma excavatum* (1.33%), *Dermacentor marginatus* (1.06%), *Haemaphysalis punctata* (0.22%), and *Hyalomma detritum* (0.06%). Ticks were collected from host animals and from vegetation via the flagging method. The species of the genus *Rhipicephalus* were present in most of the study areas, the most common being the *Rhipicephalus sanguineus* group (20/31). *Hyalomma* species were mostly collected from host animals, with *Hyalomma marginatum* being the most common species in this genus (8.83%). We also observed seasonal variations in abundance, with the highest number in May. The district with the most abundant ticks was determined to be Kızılcahamam, which had the highest tick abundance rate of 28.6%.

**Key words:** Ankara, tick, flagging, *Rhipicephalus*, *Hyalomma*

## 1. Introduction

Ticks are obligatory blood-sucking arthropods that have an important role in human and animal health. They are potential vectors of a wide range of pathogenic microorganisms, including protozoal, rickettsial, bacterial, and viral microorganisms (Sonenshine, 1991; Jongejan and Uilenberg, 2004; Anderson and Magnarelli, 2008).

Turkey is the easternmost country in the temperate climate zone of the European continent, with a high regional climatic variation. Since the emergence of Crimean–Congo hemorrhagic fever (CCHF) in Turkey in 2002, there have been many studies focused on CCHF cases (Tonbak et al., 2006; Albayrak et al., 2010; Tekin et al., 2012; Yesilbag et al., 2013). In spite of increased case reports of tick bites and CCHF cases, information regarding the presence and distribution of certain species is still limited. The first review on the tick fauna of Turkey was published in 2007 (Aydin and Bakirci, 2007). According to this report, Turkey's tick fauna is composed of 32 species from 2 families and 10 genera. Most of the published tick studies deal with its occurrence on domestic animals (Yukarı and Umur, 2002; Yay, 2004; Bakirci et al., 2012) or humans (Gargılı et al., 2010; Bursali et al., 2010; Karaer et al., 2011; Kar et al., 2013). However, comprehensive information about tick biology and ecology should be obtained by collecting unfed ticks, as tick species prefer different host species (Babos, 1965; Hornok and Farkas, 2009). The risk of humans or animals contracting CCHF disease and other tick-borne diseases might be directly linked to the questing activity of ticks. The continental climate, steppe vegetation, and domestic and wild fauna of Ankara provide suitable habitats for ticks. Additionally, Crimean–Congo hemorrhagic fever virus (CCHFV) was detected in *Hyalomma marginatum* and *Rhipicephalus bursa* in our recent study in Ankara Province, Turkey (Hekimoglu et al., 2012). Although the ticks of the region have a prominent potential for carrying tick-borne diseases, there has not been any comprehensive systematic work on hard ticks in Ankara until now. Therefore, the purpose of this study is to evaluate the ixodid tick fauna and its geographical distribution in this region.

## 2. Materials and methods

The study was performed in Ankara Province, Central Anatolia (39°56′N, 32°52′E). This province covers a total surface area of 25,938 km$^2$. In the central and southern parts of the province, the climate is continental, with steppe-type vegetation. However, in the northern part of the region, the climate changes to a more humid and wet Black Sea climate, and vegetation changes to forests (generally rare oak forests). Altitude varies between 900 and 2015 m above sea level, and mean annual temperature is 14.4 °C

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(range: –24.9 °C to 40 °C). The highest temperatures are recorded in July and August, with the coldest month being January.

The sampling was conducted monthly between April 2010 and July 2012 at 31 locations in 9 districts (Akyurt, Çubuk, Gölbaşı, Kazan, Kızılcahamam, Mamak, Nallıhan, Polatlı, Pursaklar) in Ankara (Figure 1; Table 1). Average temperature and humidity parameters of the study areas are given in Figure 2.

Ticks were collected from vegetation via flagging with a 1-$m^2$ piece of white cloth in each unit. Questing ticks that attached to the cloth were removed every 5 m to reduce the effect of tick drop-off (Li and Dunley, 1998). Each collection period lasted for 30 min. All tick specimens were kept alive and sorted into different Falcon tubes according to the date and collection locality. Temperature, humidity, and coordinates of each sampling site were recorded. Species identification was carried out according to the morphological characters with a Leica MZ-7.5 stereoscopic 200M dissection microscope with a DC-300 digital camera system (Karaer et al., 1997; Walker, 2003; Estrada-Peña et al., 2004). The ticks were then classified in small tubes by species and location and stored at –80 °C. The identification results were confirmed by the Ankara University Faculty of Veterinary Medicine, Department of Protozoology and Entomology.

Shannon's diversity index and species richness were calculated for each sampling site (Table 1).

## 3. Results

The study was performed in April 2010–July 2012 in 9 districts of Ankara Province. Ticks were sampled from host animals (cattle, sheep, goats, and turtles) and from vegetation by flagging (Tables 2 and 3).

In total, 1800 adult tick individuals were collected, including 782 *R. sanguineus* group, 660 *R. bursa*, 159 *H. marginatum*, 108 *Hae. parva*, 43 *H. aegyptium*, 24 *H. excavatum*, 19 *D. marginatus*, 4 *Hae. punctata*, and 1 *H. detritum* (Figure 3).

According to monthly distributions, the highest sampling was done in May with 545 specimens (30.27%) in 3 years. The percentage of tick specimens was found to be 26% in April, 22.94% in June, and 17.61% in July (Figure 4).

The *R. sanguineus* group was the most common tick species in the sampling areas. Adults of this species were found at 20 of the 31 locations. *H. excavatum* (4/31), *D. marginatus* (4/31), *H. aegyptium* (3/31), and *Hae. punctata* (2/31) were less common, and *H. detritum* (1/31) was found in only 1 location (Table 1).

The most ticks were collected from the Kızılcahamam district. We collected 516 specimens (28.66%) belonging to 7 tick species in Kızılcahamam, 401 samples (22.2%) in Akyurt locations, 282 (15.6%) in Kazan, 250 (13.8%) in Pursaklar, 197 (10.9%) in Çubuk, and 151 (8.38%) in Polatlı. No ticks were found in Gölbaşı (location numbers 10, 11, 12) or Mamak (location number 22) districts.

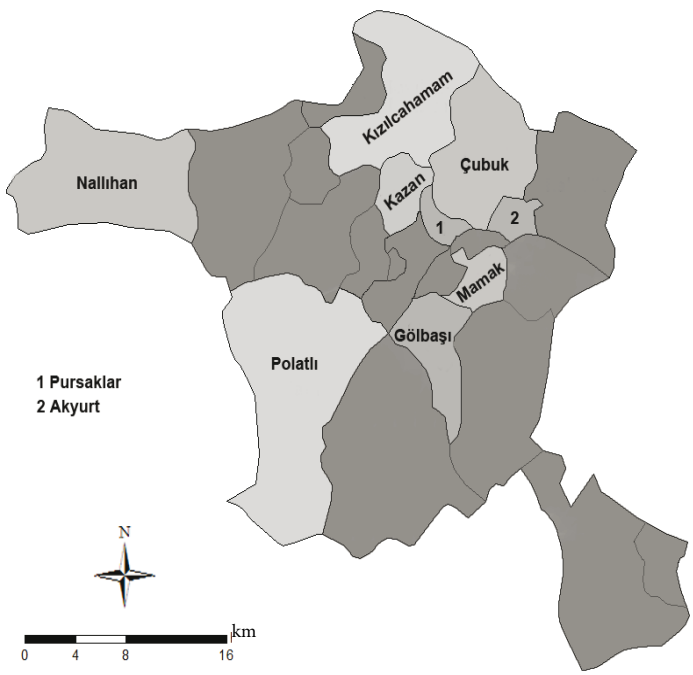


**Figure 1.** The locations of tick sampling districts within Ankara Province, Turkey.

**Table 1.** Distribution of tick species collected in Ankara Province during April 2010–July 2012.

| Location | Habitat | Coordinates | Altitude | Richness | Shannon | Tick species |
|---|---|---|---|---|---|---|
| 1 | Rural | 40.13212°N, 33.12949°E | 1104 m | 2 | 0.27 | *R. bursa*, *R. sanguineus* group |
| 2 | Urban | 40.11924°N, 33.06150°E | 952 m | 5 | 0.31 | *R. bursa*, *R. sanguineus* group, *H. aegyptium*, *Hae. parva*, *D. marginatus* |
| 3 | Meadow | 40.05666°N, 33.04544°E | 984 m | 2 | 0.29 | *R. bursa*, *R. sanguineus* group |
| 4 | Rural | 40.26739°N, 33.01846°E | 952 m | 2 | 0.3 | *R. bursa*, *H. marginatum* |
| 5 | Rural | 40.30077°N, 32.99104°E | 1296 m | 2 | 0.3 | *R. bursa*, *R. sanguineus* group |
| 6 | Meadow | 40.30956°N, 32.97519°E | 1265 m | 2 | 0.3 | *R. bursa*, *H. marginatum* |
| 7 | Rural | 40.33383°N, 33.21582°E | 1008 m | 3 | 0.37 | *R. sanguineus* group, *H. marginatum*, *D. marginatus* |
| 8 | Rural | 40.41733°N, 33.16460°E | 1088 m | 2 | 0.18 | *R. sanguineus* group, *H. marginatum* |
| 9 | Rural | 40.18264°N, 33.03411°E | 1257 m | 4 | 0.32 | *R. sanguineus* group, *H. marginatum*, *Hae. parva*, *D. marginatus* |
| 10 | Rural | 39.74113°N, 32.75352°E | 995 m | 0 | 0 | |
| 11 | Urban | 39.67078°N, 32.73656°E | 1052 m | 0 | 0 | |
| 12 | Urban | 39.65006°N, 32.72249°E | 1057 m | 0 | 0 | |
| 13 | Field (wheat) | 40.19661°N, 32.69177°E | 891 m | 3 | 0.31 | *R. bursa*, *R. sanguineus* group, *Hae. parva* |
| 14 | Rural | 40. 32025°N, 32.70362°E | 980 m | 2 | 0.29 | *R. bursa*, *R. sanguineus* group |
| 15 | Meadow | 40.39953°N, 32.67322°E | 1106 m | 5 | 0.61 | *R. bursa*, *R. sanguineus* group, *H. marginatum*, *H. excavatum*, *Hae. parva* |
| 16 | Rural | 40.36668°N, 32.65835°E | 1146 m | 3 | 0.37 | *R. bursa*, *H. marginatum*, *H. excavatum* |
| 17 | Rural | 40.33142°N, 32.45888°E | 807 m | 4 | 0.53 | *R. bursa*, *H. detritum*, *H. marginatum*, *H. excavatum* |
| 18 | Rural | 40.38202°N, 32.57475°E | 951 m | 4 | 0.32 | *R. bursa*, *R. sanguineus* group, *H. marginatum*, *D. marginatus* |
| 19 | Forest | 40.62463°N, 32. 45974°E | 1505 m | 0 | 0 | |
| 20 | Forest | 40.60077°N, 32.55079°E | 1410 m | 0 | 0 | |
| 21 | Recreational | 40.36668°N, 32.70279°E | 971 m | 3 | 0.31 | *R. bursa*, *R. sanguineus* group, *Hae. parva* |
| 22 | Meadow | 39.88942°N, 32.99228°E | 1120 m | 0 | 0 | |
| 23 | Meadow | 40.31058°N, 31.29830°E | 763 m | 1 | 0 | *H. marginatum* |
| 24 | Rural | 39.67176°N, 32.21992°E | 844 m | 2 | 0.3 | *R. sanguineus* group, *H. marginatum* |
| 25 | Meadow | 39.65435°N, 31.98485°E | 675 m | 3 | 0.29 | *R. sanguineus* group, *H. aegyptium*, *H. excavatum* |
| 26 | Rural | 39.79657°N, 32.10818°E | 875 m | 1 | 0 | *R. sanguineus* group |
| 27 | Rural | 39.49066°N, 32.11345°E | 1010 m | 1 | 0 | *R. sanguineus* group |
| 28 | Urban | 32.91779°N, 40.04893°E | 1043 m | 5 | 0.57 | *R. bursa*, *R. sanguineus* group, *H. aegyptium*, *Hae. parva*, *Hae. punctata* |
| 29 | Recreational | 40.05656°N, 32.90729°E | 992 m | 4 | 0.43 | *R. bursa*, *R. sanguineus* group, *Hae. parva*, *Hae. punctata* |
| 30 | Rural | 40.14070°N, 32.89167°E | 1014 m | 3 | 0.41 | *R. bursa*, *R. sanguineus* group, *Hae. parva* |
| 31 | Rural | 40.13851°N, 32.92035°E | 995 m | 3 | 0.34 | *R. bursa*, *R. sanguineus* group, *Hae. parva* |

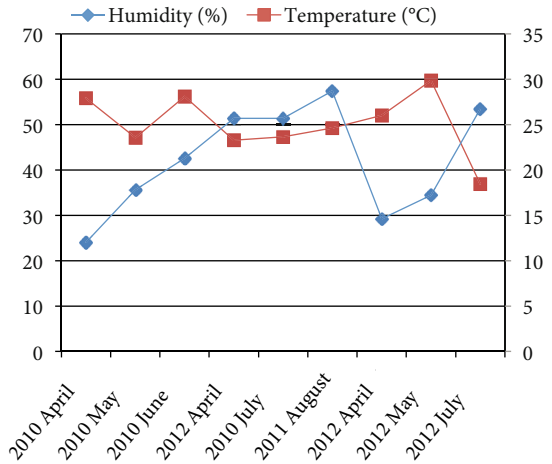


**Figure 2.** Temperature and humidity of Ankara during the period of study.

The species composition varied with sampling method, but no correlation was found between the species richness or Shannon's diversity and sampling method (species richness, P = 0.41; Shannon diversity, P = 0.51). Furthermore, neither species richness nor Shannon diversity was correlated with altitude, longitude, or latitude (P > 0.05) (Table 1).

## 4. Discussion

In recent years, there has been a substantial increase in the number of tick-borne infection cases in Turkey; thus, the scientific studies on ticks have focused mostly on CCHF cases (Tonbak et al., 2006; Albayrak et al., 2010; Gunes et al., 2011; Hekimoglu et al., 2012; Tekin et al., 2012). In fact, continuous scanning of tick distribution is crucial in order to monitor tick-borne diseases and develop effective control strategies against them.

There has been only 1 comprehensive faunistic study describing 46 tick species in Turkey (Bursali et al., 2012), and another review study indicating 32 species from 2 families and 10 genera (Aydin and Bakirci, 2007). Several recent reports have focused mainly on ticks found on domestic animals, but not questing ticks from different areas with potentially suitable habitats. Therefore, different methods of host investigation and sampling by flagging should be used together in the same area to investigate the extensive tick fauna, as tick species show great variation in their feeding behaviors and host preferences (Anderson and Magnarelli, 2008). In addition, the tick species that show a high preference for specific host species need to be studied on their specific hosts. In studies of population dynamics, a single sampling method could be preferred.

This report documents the structure of tick communities in Ankara. Between April 2010 and July

**Table 2.** The distribution of the percentages for the species collected according to sampling technique.

| Genus | Species | Flagging | Host |
|---|---|---|---|
| *Hyalomma* | *H. aegyptium* Linnaeus, 1758 | 0.00% | 100.00% |
| | *H. detritum* Schulze, 1919 | 0.00% | 100.00% |
| | *H. marginatum* Koch, 1844 | 0.6% | 99.4% |
| | *H. excavatum* Koch, 1844 | 0.00% | 100.00% |
| *Rhipicephalus* | *R. bursa* Canestrini & Fanzago, 1878 | 78.90% | 21.10% |
| | *R. sanguineus* group | 67.30% | 32.70% |
| *Haemaphysalis* | *Hae. parva* Neumann, 1897 | 89.80% | 10.20% |
| | *Hae. punctata* Canestrini & Fanzago, 1878 | 100.00% | 0.00% |
| *Dermacentor* | *D. marginatus* Sulzer, 1776 | 10.50% | 89.50% |
| Total | | 64.00% | 36.00% |

**Table 3.** The study area, the coordinates for the area, the host, and the number of specimens for *H. aegyptium*.

| Number | Study area | Coordinate | Altitude | Tortoise species | *H. aegyptium* specimens |
|---|---|---|---|---|---|
| 1 | Akyurt | 40.11924°N, 33.06150°E | 952 m | *Testudo graeca* | 10 |
| 2 | Polatlı | 39.65435°N, 31.98485°E | 675 m | *Testudo graeca* | 26 |
| 3 | Pursaklar | 32.91779°N, 40.04893°E | 1043 m | *Testudo graeca* | 7 |

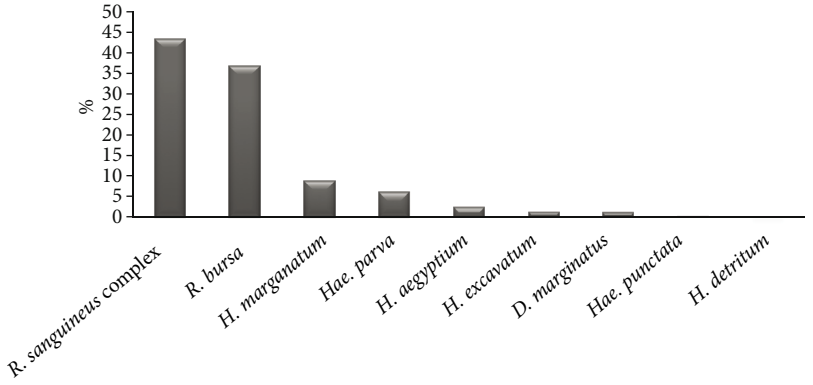


**Figure 3.** Tick species collected in Ankara in 2010–2012.

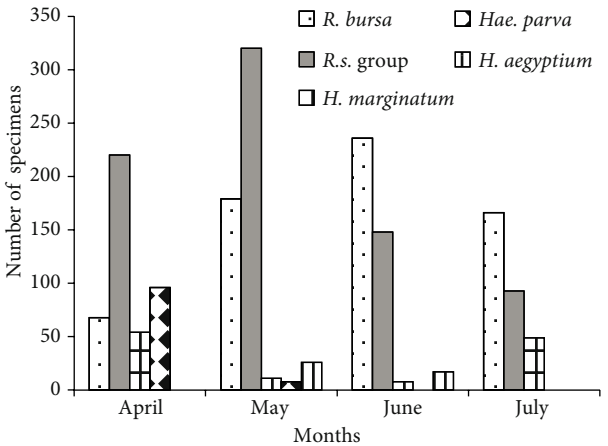


**Figure 4.** Seasonal abundance of ticks collected from April 2010 to July 2012 in Ankara Province.

2012, 1800 tick specimens were collected. The total number of tick species was 9, including the *R. sanguineus* group (43.44%), *R. bursa* (36.67%), *H. marginatum* (8.83%), *Hae. parva* (6%), *H. aegyptium* (2.39%), *H. excavatum* (1.33%), *D. marginatus* (1.06%) *Hae. punctata* (0.22%), and *H. detritum* (0.06%).

The variation in tick distribution in different areas is derived from a variety of factors such as climatic conditions, association and lifestyle of host animals, and habitat characterization (Ghosh et al., 2007). The most individuals were sampled from the Kızılcahamam district. The microclimatic conditions and vegetation in this district are similar to and partly continuous with those of northern/northeastern Anatolia, from where the first case of CCHF came. This district, 83 km from the provincial center of Ankara, is a preferred domestic tourism site for outdoor activities. We used both tick sampling methods (flagging and from host) and collected 7 tick species in this district. Generally, all sampling stations in Ankara Province had varying vegetation cover and climate, providing suitable habitats for ticks. The absence of ticks in samples from Gölbaşı and Mamak stations might be related to inconvenient microclimatic factors during the study period (end of July).

The most prevalent species in our study were those of the *R. sanguineus* group, with an abundance of 43.44%. Within the genus *Rhipicephalus*, the *R. sanguineus* group is one of the most important groups because of its capacity to transmit serious diseases. This complex contains 12 species (Zahler et al., 1997). Generally, *Hyalomma* and *Rhipicephalus* species were more prevalent among the ticks collected from human hosts in Turkey (Vatansever et al., 2008; Bursali et al., 2010). This conclusion is consistent with our results. However, *Hae. punctata*, *H. detritum*, *H. excavatum*, and *D. marginatus* were sampled from only some stations, and *Hyalomma* species could only be sampled by host examinations, not by flagging. *H. marginatum* and *H. excavatum* were collected primarily from cattle and sheep, unlike *H. aegyptium*, which was collected only from turtles. *Rhipicephalus* species and *Hae. parva* were sampled using both methods.

Among *Haemaphysalis* species, *Hae. parva* and *Hae. punctata* were detected in this study, but *Haemaphysalis sulcata* was not found; it was previously recorded in low numbers by Karaer et al. (2011) in the study area. *Haemaphysalis* species were collected only in April. Additionally, *Hae. parva* and *Hae. punctata* have been typically observed infesting domestic animals such as goats, sheep, and cattle in Ankara Province (Çiçek, 2004). Ticks from *Ornithodoros* or *Otobius* spp. were not detected, despite having been found in some regions in Central Anatolia previously (Aydin and Bakirci, 2007).

*Ixodes ricinus*, one of the most important tick species in Europe, was not detected in our study area. In Turkey, *I. ricinus* has been recorded in several studies (Güner et al., 2003; Masuzawa et al., 2005; Sen et al., 2005; Gargılı et al., 2006, 2007; Albayrak et al., 2010), especially in

humid areas that have substantial secondary plant growth such as river canopies, mixed forests, and deciduous heterogeneous woods, but not in Ankara to date (Estrada-Peña, 2001; Şen, 2007). According to Aydin and Bakirci (2007), *I. ricinus* has been observed only in rainy and forested parts of northern and northwestern Anatolia, located by the coasts of the Black Sea and the Marmara Sea, suggesting that this species is not common in Ankara in Central Anatolia.

If we look at the monthly distribution of tick samples, the greatest numbers of samples were found in May, when the mean temperature was 16.6 °C, average rainfall 56.4 mm, and average humidity 57.06%. Additionally, the highest numbers of the *R. sanguineus* group were observed in May and June for *R. bursa*. The number of collected ticks was 545 (30.27%) in May, 468 (26%) in April, 413 (22.94%) in June, and 317 (17.6%) in July. Various ecological factors influence the distribution and abundance of tick vectors. High temperatures (25.3 °C) and low humidity (40.7%) in August would have affected tick distribution. Ticks could be absent in August in vegetation as they might be hiding on their appropriate hosts, or they may lay eggs in cryptic habitats in the field.

In Karaer et al.'s study carried out in the same area in 2011, the total number of tick species was recorded as 11, but all of the samples were taken from hospitalized people who had experienced tick bites. In that study, the most common species was *H. marginatum* with a rate of 16.82%, showing its feeding preference for humans (Karaer et al., 2011). According to previous studies, *Hyalomma*, *Dermacentor*, *Rhipicephalus*, and *Haemaphysalis* species constituted the majority of species collected from humans and the field (Aydin and Bakirci, 2007; Karaer et al., 2011). These results are also in accordance with our studies.

The other studies that have been conducted in Ankara Province (Güler, 1982; Zeybek and Kalkan, 1984; Sayın and Karaer, 1987) were performed using only one method and certain hosts. It is certain that it is not possible to perform a faunal study with just one genus. In our study, we used both sampling techniques used everywhere in the world and we collected our samples from different hosts.

In this study, we evaluated the species diversity (Shannon diversity) and species richness of ixodid ticks in study areas in Ankara. Neither species richness nor species diversity was correlated with altitude, longitude, latitude, or sampling method. This may be related to the small number of specimens or the small number of sampling sites.

Vector surveillance programs, ranging from local to regional levels, are required for monitoring the introduction of emerging and reemerging diseases and should be continuously carried out by different study groups.

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