Eurasian Journal
of Veterinary Sciences

www.eurasianjvetsci.org

RESEARCH ARTICLE

Prevalence of hard ticks (Acari: Ixodidae) in spur-thighed tortoise (*Testudo graeca ibera*) population of Konya

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Received:21.01.2019, Accepted: 17.04.2019
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Konya'nın mahmuzlu akdeniz kaplumbağa (*Testudo graeca ibera*) populasyonunda sert kenelerin (Acari: Ixodidae) yaygınlığı

Eurasian J Vet Sci, 2019, 35, 3, 158-164
DOI: 10.15312/EurasianJVetSci.2019.239

Öz

Amaç: Bu çalışma, insanlarda ve hayvanlarda birçok hastalığın naklinde rol oynayan ixodid kene türlerinin, mahmuzlu akdeniz kaplumbağalarındaki yaygınlığını belirlemek amacıyla yapılmıştır.

Gereç ve Yöntem: Keneler, %70 etanol içeren numune toplama şişelerine konularak parazitoloji laboratuvarına getirilmiş ve standart teşhis anahtarları ile taksonomik olarak teşhis edilmişlerdir.

Bulgular: 65 kaplumbağanın tümü keneler ile enfeste bulunmuştur. Kaplumbağalarda 3 kene türü (*Hyalomma aegyptium, H. marginatum marginatum* ve *Rhipicephalus turanicus*) tespit edilmiştir. Kaplumbağaların çoğunluğunun (% 89.2) sadece bir kene türü (*H. aegyptium*) ile enfeste olduğu, buna karşın 7 kaplumbağanın (%10.8) 2 kene türü (4'ü *H. aegyptium* ve *R. turanicus*, 3'ü ise *H. aegyptium* ve *H. m. marginatum*) ile koenfeste olduğu belirlenmiştir. Daha önce Türkiye'de kaplumbağalarda sadece *H. aegyptium*'un enfestasyona neden olduğu bildirilmesine rağmen, bu çalışma ile *H. m. marginatum* ve *R. turanicus*'un da enfestasyon etkenleri oldukları ortaya konmuştur.

Öneri: Konya bölgesindeki kaplumbağaların toplam popülasyonunun, optimum çevresel uyumluluk ile beraber sert kenelerin kaplumbağa popülasyonunda yerleşim ve çoğalmalarını desteklediği sonucuna varılmıştır.

Anahtar kelimeler: *Testudo graeca ibera, Hyalomma aegyptium, Hyalomma marginatum marginatum, Rhipicephalus turanicus*, Konya

Abstract

Aim: This study was carried out to determine the prevalence of ixodid tick species which play a role in the transmission of many diseases in humans and animals in spur-thighed tortoises.

Materials and Methods: Ticks were brought to the Laboratory of Parasitology by putting in sample collection bottles containing 70% ethanol and and were taxonomically identified was using standard keys.

Results: All tortoises were found infested with ticks. Three species of ticks viz; *Hyalomma aegyptium*, *H. marginatum marginatum* and *Rhipicephalus turanicus* were detected in the tortoises. Majority of tortoises (89.2%) were found infested with *H. aegyptium* only. However, seven (10.8%) were found infested with more than one tick species (4 of 7 co-infested with *H. aegyptium* and *R. turanicus* and 3 of 7 co-infested with *H. aegyptium* and *H. m. marginatum*). Earlier, *H. aegyptium* was the only tick species reported from tortoises of Turkey. As a result of this study, *H. m. marginatum* and *R. turanicus* have also been shown to be infestation agents.

Conclusion: It is concluded that the contiguous population of tortoises in Konya region together with optimum environmental compatibility favor the settlement and propagation of hard ticks in the tortoise population.

Keywords: *Testudo graeca ibera*, *Hyalomma aegyptium*, *Hyalomma marginatum marginatum*, *Rhipicephalus turanicus*, Konya

Introduction

Turkey geographically located in Eurasia. The economy of the country is largely based upon the agricultural and industrial products. Turkey is divided into seven distinct geographical regions. Due to its location and climatic suitability, Turkey is a hub of stay of migratory birds of Asia, Europe and Africa. Therefore, Turkey has a diversified tick fauna and tick-borne diseases due to these migratory birds. Tick fauna of Turkey consists of about 46 different tick species belonging to seven genera. These tick species have been reported from all over the country parasitizing ruminants, reptiles, amphibians, poultry and humans as well. A variety of bacteria, viruses and protozoa which are the ordinary inhabitants of gut microflora of ticks has been transmitted to their host animals due to vector role of ticks. These micro-organisms cause various infectious diseases in animals and humans. A recent outbreak of CCHF in different countries of the world is also supposed to be caused due to the vectoral capability of ticks (Guglielmone et al 2009, Bursalı et al 2012).

The spur-thighed tortoise (*Testudo graeca*; Linneaus 1758) is one of the five species of the Mediterranean tortoises belonging to family Testudinidae which are herbivorous vertebrates. Testudo tortoises are among the most essential pet tortoises and account for over 80% trade in live Testudinidae worldwide (Theile 2002). Tortoises are present in many parts of the world ranging from North Africa (Libya, Morocco) to Europe (Spain, Sardinia, Malta, Italy and western Peninsula) and Transcaucasian countries (Iraq, Iran, Lebanon and Jordan) (Ananjeva et al 2006, Bonin et al 2006, Sultana Loporto et al 2018). Mediterranean tortoises have a wide geographic distribution than Egyptian tortoises which are limited only to Israel, Egypt and Libya (Rhodin et al 2017). In Turkey, the most common subspecies is *T. g. ibera*. Their habitat is wastelands, barren hillsides, dry steppes, dry woodlands, gardens, orchards and recreational fields where intense vegetation of grasses is present (Vatansever et al 2008). They are also kept in houses as pets because unlike other reptiles; they are harmless for humans (Tavassoli et al 2007). They are an essential host for different species of hard ticks.

Ticks (Acari: Ixodidae) are obligate and non-permanent ectoparasitic arthropods that can infest terrestrial, marine and flying vertebrates (Tavassoli et al 2007) and have coined significance in terms of one-health perspective. All of the three developmental stages of the hard ticks (larvae, nymph and adult) can feed on vertebrates, but adults of some species mainly are particular to tortoises. They pose direct and indirect damages to their hosts. There are over 30 species of Hyalommines and more than 15 are vectors of infectious zoonotic diseases. Ticks suck blood from their hosts to feed and can be a source of infection for humans and animals; therefore, act as an indicator of infection in nature (Rizzoli et al 2011). The geographical distribution and habitats of several tick species have been changed in the recent past and this might be attributable to climate change, globalization and transportation of animals (Harrus and Baneth 2005). Ticks are not host-specific and have been observed to switch their host and adapt to other host species; might be due to the unavailability of the preferred host in a particular area (Keesing et al 2010). Hyalomma ticks also can adapt and feed on a wide variety of hosts depending upon their availability. Tortoises can be a source of spread of different tick species from one country to another. It has been reported that almost eight different tick species have been imported to Florida due to the transportation of tortoises from other parts of the world (Norval 1985). About 78 *H. aegyptium* ticks have been imported to Poland (Nowak 2010) and 798 *H. aegyptium* ticks to Italy from North Africa by the transportation of tortoises (Brianti et al 2010).

Hyalommines are three-host ornate ticks having larger mouthparts with longer hypostomes (Mihalca et al 2011). Mostly, the immature stages of Hyalomma species feed on reptiles but in case of *H. aegyptium*; also called as "tortoise tick", adult stage parasitizes on reptiles (Barnard and Durden 2000). *H. aegyptium* has a broader host spectrum all around the world, parasitizing tortoises in Romania, Turkey, Iran and Malta; lizards, hedgehogs, hamsters, horses and dogs in Europe (Hillyard 1996, Tavassoli et al 2007, Sultana Loporto et al 2018) cattle and buffalo in Asia (Aydin 2000). Larvae and nymphs of *H. aegyptium* are not host-specific and can feed on any available vertebrate host; while, adults seem to be host-specific to some extent as mostly feed on tortoises but can also take a blood meal from hedgehogs and hares (Bursalı et al 2010). Reptiles are the reservoir hosts of many pathogens (Majlathova et al 2008) and *H. aegyptium* ticks, infesting these to take a blood meal, have been reported to transmit various pathogens viz; Rickettsia (Kar et al 2011) Borrelia (Guner et al 2004) and Theileria (Ray 1950). Therefore, the objective of this study was to elucidate the degree of adaptability and spectrum of ixodid ticks infesting spur-thighed tortoise population as reservoir or maintenance host in the urban and peri-urban areas of Konya, Turkey.

Materials and Methods

The study was planned in Konya (37.8746° N, 32.4932° E), Turkey; nestled in the heart of Anatolian plateau and south of Ankara. It is known for its pilgrimage destination for the Sufis. It is one of the oldest inhabited cities of Turkey and seventh most populous city of Turkey having over 2.1 million human population. Konya has a cold semi-arid climate with an average temperature of 30˚C during summer. A total of 778 ticks were collected from 65 adult tortoises screened for ticks. All of the tortoises were found positive for tick infestation. Tick specimens were placed in labelled bottles having 70% ethanol under aseptic conditions and transported to Department of Parasitology, Selcuk University, Konya,

Table 1. Tortoises, numbers of collected ixodid ticks, genders and species of ixodid ticks

Tortoise Number	Number of Ticks	Males	Females	Nymphs	Ticks Species
1	7	5	2		*H. aegyptium*
	3	1	2		*H.marginatum marginatum*
2	4	4			*H. aegyptium*
3	6	2	4		*H. aegyptium*
	8	1	7		*H.marginatum marginatum*
4	4	1	3		*H. aegyptium*
	1	-	1		*H.marginatum marginatum*
5	13	12	1		*H. aegyptium*
6	3	2	1		*H. aegyptium*
7	11	8	3		*H. aegyptium*
8	10	3	7		*H. aegyptium*
9	4	3	1		*H. aegyptium*
10	8	6	2		*H. aegyptium*
11	10	8	2		*H. aegyptium*
12	30	10	20		*H. aegyptium*
13	1	1			*H. aegyptium*
14	3	1	2		*H. aegyptium*
15	4	2	2		*H. aegyptium*
16	34	28	5	1	*H. aegyptium*
17	2	1	1		*H. aegyptium*
18	4	1	3		*H. aegyptium*
19	5	2	3		*H. aegyptium*
20	2	1	1		*H. aegyptium*
21	5	3	2		*H. aegyptium*
22	3	2	1		*H. aegyptium*
23	11	3	8		*H. aegyptium*
24	17	11	6		*H. aegyptium*
25	22	15	7		*H. aegyptium*
26	20	14	6		*H. aegyptium*
27	29	20	9		*H. aegyptium*
28	28	17	11		*H. aegyptium*
29	7	7			*H. aegyptium*
30	32	28	4		*H. aegyptium*
31	11	9	2		*H. aegyptium*
32	30	23	7		*H. aegyptium*
	1	-	1		*R. turanicus*
33	12	7	5		*H. aegyptium*
34	16	11	5		*H. aegyptium*
35	6	4	2		*H. aegyptium*
36	18	12	6		*H. aegyptium*
37	26	19	7		*H. aegyptium*
38	6	5	1		*H. aegyptium*
39	2		2		*H. aegyptium*
40	20	11	9		*H. aegyptium*
	1	-	1		*R. turanicus*
41	5	2	3		*H. aegyptium*
42	15	3	12		*H. aegyptium*
	1	-	1		*R. turanicus*
43	8	2	6		*H. aegyptium*
44	10	9	1		*H. aegyptium*
45	3	1	2		*H. aegyptium*
46	10		10		*H. aegyptium*
47	13	5	8		*H. aegyptium*
48	14	1	13		*H. aegyptium*
49	7	5	2		*H. aegyptium*
50	35	25	10		*H. aegyptium*
51	18	11	7		*H. aegyptium*
52	26	24	2		*H. aegyptium*
	1	-	1		*R. turanicus*
53	35	32	3		*H. aegyptium*
54	2	2			*H. aegyptium*
55	2	2			*H. aegyptium*
56	5	5			*H. aegyptium*
57	1	1			*H. aegyptium*
58	18	3	15		*H. aegyptium*
59	1	1			*H. aegyptium*
60	1		1		*H. aegyptium*
61	20		20		*H. aegyptium*
62	6	6			*H. aegyptium*
63	3	3			*H. aegyptium*
64	12	10	2		*H. aegyptium*
65	6	4	2		*H. aegyptium*
Total	778	481	296	1	

Turkey. Tick identification was done under stereomicroscope after washing with 10% potassium hydroxide using the standard keys of (Walker 2003).

Results

Two species of Hyalomma (*H. aegyptium* & *H. marginatum*) and one species of Rhipicephalus (*R. turanicus*) were found prevalent in the tortoise population of Konya, Turkey. Of 778 examined tick species, 481 (61.82%) were males, 296 (38.04%) were females and one nymph was found. Of 481 males, 479 (99.6%) were identified as *H. aegyptium* and 2 were (0.42%) *H. marginatum*. Of 296 females, 282 (95.3%) were identified as *H. aegyptium*, 10 (3.4%) were *H. marginatum* and 4 (1.35%) were *R. turanicus* as shown in Table 1.

Results of the taxonomy of the ticks have shown that 58 (89.2%) out of 65 tortoises were found infested only with *H. aegyptium*. However, seven of 65 tortoises (10.8%) were found infested with more than one tick species. Four tortoises were found co-infested with *H. aegyptium* and *R. turanicus*. Three tortoises were found co-infested with *H. aegyptium* and *H. marginatum marginatum*. Most of the tortoises (36/65; 55.3%) were infested with 01-10 ticks per tortoise, 17/65; 26.15% were infested with 11-20 ticks per tortoise, 7/65; 10.77% were found infested with 21-30 ticks per tortoise, while, 5/65; 7.69% showed maximum infestation of ticks and were found infested with >30 ticks per tortoise. However, on an average, the abundance of ticks was found 11.96% per tortoise.

Discussion

In Turkey, people mostly carry tortoises in their houses as pets and they are also present in numbers in their natural habitats, e.g. dry woodlands, wastelands, gardens, orchards and areas of intense vegetation. Hard ticks are considered as principal reservoirs of crucial public health related diseases. Multiplication of pathogen inside the ticks and transovarian transmission are among the prime factors involved in the survivability of pathogens in ticks (Rizzoli et al 2011, Socolovschi et al 2009). They can transmit pathogens of many diseases including Crimean Congo hemorrhagic fever, rickettsiosis, borreliosis, theileriosis and anaplasmosis (Paddock 2009). Ticks almost infest every vertebrate animal including mammals, birds, reptiles and amphibians. Tortoises are one of the reservoir hosts for ticks. They are commonly prevalent in North Africa, Europe, South West Asia and the Middle East (Tavassoli et al 2007, Rhodin et al 2017). Prevalence of hard ticks in tortoises is reported from all over the world (Garces-Restrepo et al 2013, Ehlers et al 2016, Rodriguez-Vivas et al 2016, Banafshi et al 2018, Nader et al 2018).

In the current study, higher prevalence of *H. aegyptium* is reported in examined tortoises which is following previous studies from different regions of the world (Siroky et al 2009, Gazyagcı et al 2010, Siroky et al 2010, Kalmar et al 2015, Yilmaz et al 2018). *H. aegyptium* in tortoises from the Shahrekord town, Iran was reported (Kheirabadi et al 2016). The ticks were adhered to the carapace of the tortoises that was not a typical location of tick infestation in tortoises. Two hundred eleven tortoises were screened and 1327 ticks were collected belonging to *H. aegyptium*, *Haemaphysalis sulcata, R. sanguineus* and *H. inermis.* Among these, a higher prevalence of *H. aegyptium* was recorded as compared to other species and genera (Siroky et al 2006). *H. aegyptium* was also reported in different regions of Algeria (Tiar et al 2016). *H. aegyptium* prevalence was also reported from Italy (Brianti et al 2010). In North Africa *H. aegyptium* ticks infesting tortoises were also reported (Harris et al 2013). A total of 60 tortoises were screened and all of the ticks collected from these tortoises were *H. aegyptium*. In Iran 100% prevalence of *H. aegyptium* were also reported and all 264 examined tortoises were positive for ticks (Javanbakht et al 2015). Two hundred ten tortoises were screened and 602 ticks were collected and all were belonging to single species i.e *H. aegyptium* (Gharbi et al 2015). In Malta, first time reported *H. aegyptium* prevalence in male and female tortoises (Sultana Loporto et al 2018). In Spain, *H. aegyptium* was reported in captive tortoise colony (Mihalca 2015). Prevalence of *H. aegyptium* also reported from Kurdistan, Iran (Banafshi et al 2018).

H. aegyptium has also been reported from various parts of Turkey as a significant tick infesting tortoises. In Erciş district of Van Province in Turkey, 37 tortoises were screened and found 100% infestation of *H. aegyptium* (71.84% females and 28.15% males) (Yilmaz et al 2013). Eighty-four tortoises were screened from Kahramanmaraş, Turkey and 272 ticks were collected from them. All of the ticks (100%) were identified as *H. aegyptium* (Kirecci et al 2013). Ticks were screened from different animals from various localities (e.g. urban, rural, recreational, fields) of Ankara for tick infestation and found 2.39% infestation of *H. aegyptium* from tortoises. The number of tortoises found infested with *H. aegyptium* were 10, 26 and 7 from Akyurt, Polatlı, and Pursaklar regions, respectively (Hekimoglu and Ozer 2015). Prevalence of *H. aegyptium* also reported in tortoise from Turkish Thrace where a total of 56 tortoises were screened and 98.21% of those were found infested for *H. aegyptium*. In Istanbul, *H. aegyptium* in tortoises were reported. Total 438 ticks were collected from tortoises and hedgehogs and all of the collected ticks were found as *H. aegyptium* (Kar et al 2011). In Southern Turkey, 100% prevalence of *H. aegyptium* was reported from tortoises. A total of 245 ticks were collected from 38 tortoises (Siroky et al 2014). In Turkey, *H. aegyptium* prevalence was reported in reptiles mainly focusing on tortoises and lizards and reported 66.66% prevalence in tortoises and 28.57% in lizards (Yilmaz et al 2018).

H. aegyptium has a wider host range. Although it is preferred parasitizing host is tortoises but the unavailability of

its natural host push *H. aegyptium* to switch its host (Pastiu et al 2012). *H. aegyptium* is also found to commonly infest cattle and buffalos in Russia, India, Iran, Turkey and Pakistan (Siroky et al 2006, Gazyagcı et al 2010, Rafiq et al 2017). *H. aegyptium* was also reported from cattle, sheep and goat (Telmadarraiy et al 2004). In Turkey *H. aegyptium* along with R. bursa, R. sanguineus, *R. turanicus, Hae. parva, H. marginatum marginatum*, *H. aegyptium*, *H. anatolicum excavatum*, and *Dermacentor marginatus* in mammals from Ankara region (Hekimoglu et al 2012). Prevalence of *H. aegyptium* also reported in wild animals in Turkey (Orkun and Karaer 2017). In Istanbul, *H. aegyptium* is also reported to bite humans (Vatansever et al 2008).

In Southern Europe, *H. aegyptium* is recorded from reptiles, horses and birds; while, in Romania and Iran, these are reported from tortoises. In Italy, they were found infesting partridges and in Egypt, they were reported from quails, pigeons, chats and warblers (Hillyard 1996, Majlathova et al 2008). Habitat and distribution of different tick species have expanded in recent past presumably due to change in climatic conditions, increase in land use and urbanization (Harrus and Baneth 2005) and unavailability of a natural host which may lead to the host-switching behavior of ticks (Keesing et al 2010). To the best of our knowledge *H. m. marginatum* and *R. turanicus* are the first time reported from tortoises in this area.

The presence of *H. aegyptium* and other species in this part of Turkey is of prime medical and biological significance because these ectoparasites are known to be the potential vectors of many infectious diseases that can affect humans too such as Lyme disease, Q fever and Crimean Congo hemorrhagic fever (CCHF) (Kalmar et al 2015). A total of 19 different tick-borne infections have been reported from seven regions of Turkey including Konya. These TBDs are equally common in animals and humans due to the suitable climatic and environmental conditions of Turkey. Hence, due to the suitable conditions, there is a very high endemicity of ticks in this part of the world. Tick fauna of Turkey had also increased during annual migration of wild birds when millions of migratory birds came to Turkey. These migrated birds also add up to the existing disease burden. These ticks transmit different lethal infections to their hosts (animals and humans) during blood feeding. These infections pose serious public health threats and significant economic loss. That is why Turkey should focus on the establishment of tick control programs and disease management strategy.

Conclusions

The spur-thighed tortoises (*Testudo graeca ibera*) are significant in the completion of life cycle for a majority of parasitic fauna in Turkey. Hard ticks are among the significant ectoparasites of livestock maintaining their questing phases on wild animals and reptiles including tortoises. In this paper, it is concluded that the contiguous population of tortoises in Konya region together with optimum environmental compatibility favor the settlement and propagation of hard ticks in the tortoise population.

Acknowledgements

This paper was orally presented at 8. International Scientific Meeting 'Days of Veterinary Medicine 2018' and the 5. VETistanbul Group Congress, 2018.

References

Ananjeva NB, Orlov NL, Khalikov RG, Darevsky IS, et al., 2006. An atlas of the reptiles of north Eurasia: Taxonomic diversity, distribution, conservation status. Pensoft Publishers.

Aydın L, 2000. Distribution and species of ticks on ruminants in the Southern Marmara Region. Türkiye Parazitol Derg. 24 (2), 194-200.

Banafshi O, Hanafi-Bojd AA, Karimi M, Faghihi F, et al., 2018. Tick Ectoparasites of Animals in Borderline of Iran-Iraq and Their Role on Disease Transmission. J Arthropod-Borne Dis. 2-10.

Barnard SM, Durden LA, 2000. Order: parasitiformes, superfamily: Ixodoidea (ticks). In: Barnard SM, Durden LA (Ed): A veterinary guide to the parasites of reptiles. Arhropods (excluding mites). Vol2., 57–189, Krieger Publishing Company, Florida (FL).

Bonin F, Devaux B, Dupré A, 2006. Turtles of the World. Baltimore- The John Hopkins University Press.

Brianti E, Dantas-Torres F, Giannetto S, Risitano A, et al., 2010. Risk for the introduction of exotic ticks and pathogens into Italy through the illegal importation of tortoises Testudo graeca. Med Vet Entomol. 24 (3), 336–339.

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(1), 91-104.

Bursali A, Tekin S, Orhan M, Keskin A, et al., 2010. Ixodid ticks (Acari: Ixodidae) infesting humans in Tokat Province of Turkey: species diversity and seasonal activity. J Vector Ecol. 35(1), 180-186.

Ehlers J, Ganzhorn JU, Silaghi C, Krüger A, et al., 2016. Tick (Amblyommachabaudi) infestation of endemic tortoises in southwest Madagascar and investigation of tick-borne pathogens. Ticks Tick Borne Dis. 7 (2), 378-383.

Garcés-Restrepo MF, Giraldo A, Carr JL, Brown LD, 2013. Turtle ectoparasites from the Pacific coastal region of Colombia. Biota Neotrop. 13 (3), 74-79.

Gazyagci S, Asan N, Demirbas Y, 2010. A common tortoise tick, HyalommaaegyptiumLinne 1758 (Acari: Ixodidae), identified on eastern hedgehog (Erinaceusconcolor Martin 1838) in Central Anatolia. Turk J Vet AnimSci. 34 (2), 211-213.

Gharbi M, Rjeibi MR, Rouatbi M, Mabrouk M, et al., 2015. In-

festation of the spur-thighed tortoise (Testudo graeca) by *Hyalomma aegyptium* in Tunisia. Ticks Tick Borne Dis. 6 (3), 352-355.

Guglielmone AA, Robbins RG, Apanaskevich DA, Petney TN, et al., 2009. Comments on controversial tick (Acari: Ixodida) species names and species described or resurrected from 2003 to 2008. Exp Appl Acarol. 48 (4), 311.

Guner ES, Watanabe M, Hashimoto N, Kadosaka T, et al., 2004. Borrelia turcica sp. Nov., isolated from the hard tick *Hyalomma aegyptium* in Turkey. Int J Syst Evol Microbiol. 54 (5), 1649-1652.

Harris DJ, Graciá E, Jorge F, Maia JPMC, et al., 2013. Molecular detection of Hemolivia (Apicomplexa: Haemogregarinidae) from ticks of North African Testudo graeca (Testudines: Testudinidae) and an estimation of their phylogenetic relationships using 18S rRNA sequences. Comp Parasitol. 80 (2), 292-296.

Harrus S, Baneth G, 2005. Drivers for the emergence and re-emergence of vector-borne protozoal and bacterial diseases. Int J Parasitol. 35 (11-12), 1309-1318.

Hekimoglu O, Nurdan O, Koray E, Aykut O, 2012. Species distribution and detection of Crimean Congo hemorrhagic fever virus (CCHFV) in field-collected ticks in Ankara Province, Central Anatolia, Turkey. Exp Appl Acarol. 56 (1), 75-84.

Hekimoglu O, Ozer AN, 2015. Distribution of hard tick species in Ankara, Turkey. Turk J Zool. 39 (2), 256-262.

Hillyard PD, 1996 Ticks of North-West Europe. 178, Field Studies Council, Shrewsbury, UK.

Javanbakht H, Široký P, Mikulíček P, Sharifi M, 2015. Distribution and abundance of Hemolivia mauritanica (Apicomplexa: Haemogregarinidae) and its vector *Hyalomma aegyptium* in tortoises of Iran. Biologia. 70 (2), 229-234.

Kalmár Z, Cozma V, Sprong H, Jahfari S, et al., 2015. Transstadial transmission of Borrelia turcica in *Hyalomma aegyptium* ticks. PloS One. 10 (2), e0115520.

Kar S, Yilmazer N, Midilli K, Ergin S, et al., 2011. Presence of the zoonotic Borrelia burgdorferi sl. and Rickettsia spp. in the ticks from wild tortoises and hedgehogs. Marmara Üniversitesi Saglik Bilimleri Enstitüsü Dergisi. 1 (3), 166.

Keesing F, Belden LK, Daszak P, Dobson A, et al., 2010. Impacts of biodiversity on the emergence and transmission of infectious diseases. Nature. 468 (7324), 647-652.

Kheirabadi KP, Samani AD, Shokohi A, Dehsahraei HS, 2016. An Infestation by *Hyalomma aegyptium* (Acari: Ixodidae) on the Lesions of Break Carapace of a Turtle (Testudo graeca Ibera). J Vet Med Res. 3 (1), 1042.

Kirecci E, Ozer A, Balkaya I, Tanis H, et al., 2013. Identification of Ticks on Tortoises (Testudo graeca) and Investigation of Some Pathogens in these Ticks in Kahramanmaraş, Turkey. KSU J Nat Sci. 16 (1), 42-46.

Majláthová V, Majláth I, Hromada M, Tryjanowski P, et al., 2008. The role of the sand lizard (Lacerta agilis) in the transmission cycle of Borrelia burgdorferi sensu lato. Int J Med Microbiol. 298 (1), 161–167.

Mihalca AD, 2015. Ticks imported to Europe with exotic reptiles. Vet Parasitol. 213 (1), 67–71.

Mihalca AD, Gherman CM, Cozm V, 2011. Coendangered hard-ticks: threatened or threatening?. Parasit Vectors. 4 (1), 71.

Nader J, Król N, Pfeffer M, Ohlendorf V, et al., 2018. The diversity of tick-borne bacteria and parasites in ticks collected from the Strandja Nature Park in south-eastern Bulgaria. Parasit Vectors. 11 (1), 165.

Norval RAI, 1985. The ticks of Zimbabwe: The genus Aponomma. Zimbab Vet J, 16, 5–8.

Nowak M, 2010. The international trade in reptiles (Reptilia) - the cause of the transfer of exotic ticks (Acari: Ixodida) to Poland. Vet Parasitol. 169 (3-4), 373–381.

Orkun O, Karaer Z, 2017. Molecular characterization of Babesia species in wild animals and their ticks in Turkey. Infect Genet Evol. 55, 8-13.

Paddock CD, 2009. The science and fiction of emerging rickettsioses. Ann NY Acad Sci. 1166 (1), 133-143.

Pastiu AI, Matei IA, Mihalca AD, D'Amico G, et al., 2012. Zoonotic pathogens associated with *Hyalomma aegyptium* in endangered tortoises: evidence for host-switching behaviour in ticks? Parasit Vectors. 5 (1), 301.

Rafiq N, Kakar A, Ghani A, Iqbal A, et al., 2017. Ixodid Ticks (Arachnida: Acari) Prevalence Associated with Risk Factors in the Bovine Host in District Quetta, Balochistan. Pak J Zool. 49 (6), 2113-2121.

Ray HN, 1950. Hereditary transmission of Theileria annulata infection in the tick, *Hyalomma aegyptium* neum. Trans R Soc Trop Med Hyg. 44 (1), 93-104.

Rhodin AGJ, Iverson JB, Bour R, Fritz U, et al., 2017. Turtles of the world. Annotated checklist and atlas of taxonomy, synonymy, distribution, and conservation status. 8th ed. http://www.iucn-tftsg.org/checklist/

Rizzoli A, Hauffe H, Carpi G, Vourc HG, et al., 2011. Lyme borreliosis in Europe. Euro Surveill. 16 (27), p.e 19906.

Rodríguez-Vivas RI, Apanaskevich DA, Ojeda-Chi MM, Trinidad-Martínez I, et al., 2016. Ticks collected from humans, domestic animals, and wildlife in Yucatan, Mexico. Vet Parasitol. 215, 106-113.

Široký P, Bělohlávek T, Papoušek I, Jandzik D, et al., 2014. Hidden threat of tortoise ticks: high prevalence of Crimean-Congo haemorrhagic fever virus in ticks *Hyalomma aegyptium* in the Middle East. Parasit Vectors. 7 (1), 101.

Široký P, Kubelová M, Modrý D, Erhart J, et al., 2010. Tortoise tick *Hyalomma aegyptium* as long term carrier of Q fever agent Coxiella burnetii—evidence from experimental infection. Parasitol Res. 107 (6), 1515-1520.

Široký P, Mikulíček P, Jandzík D, Kami H, et al., 2009. Co-distribution pattern of a haemogregarine Hemolivia mauritanica (Apicomplexa: Haemogregarinidae) and its vector *Hyalomma aegyptium* (Metastigmata: Ixodidae). J Parasitol. 95 (3), 728-733.

Široký P, Petrželková KJ, Kamler M, Mihalca AD, et al., 2006. *Hyalomma aegyptium* as dominant tick in tortoises of the genus Testudo in Balkan countries, with notes on its host preferences. Exp Appl Acarol. 40 (3-4), 279-290.

Socolovschi C, Mediannikov O, Raoult D, Parola P, 2009. The relationship between spotted fever group Rickettsiae and

Ixodid ticks. Vet Res. 40 (2), 1-20.

Sultana Loporto L, Morganti G, Moretta I, Schembri PJ, 2018. A first record of the tortoise tick, *Hyalomma aegyptium* (Linnaeus 1758) on Malta. Int J Acarol, 44 (1): 49-51.

Tavassoli E, Rahimi-Asiabi N, Tavassoli M, 2007. *Hyalomma aegyptium* on Spur-thighed Tortoise (Testudograeca) in Urmia Region West Azerbaijan, Iran. Iranian J of Parasitol. 2 (2), 40–47.

Telmadarraiy Z, Bahrami A, Vatandoost H, 2004. A survey on fauna of ticks in West Azerbaijan Province, Iran. Iran J Public Health. 33 (4), 65-69.

Theile S, 2002. International trade in live Testudinidae: review of trade levels and trends over two decades. Cheloniii. 3, 268-276.

Tiar G, Tiar-Saadi M, Benyacoub S, Rouag R, et al., 2016. The dependence of *Hyalomma aegyptium* on its tortoise host Testudo graeca in Algeria. Med Vet Entomol. 30 (3), 351-359.

Vatansever Z, Gargili A, Aysul NS, Sengoz G, et al., 2008. Ticks biting humans in the urban area of Istanbul. J Parasitol Res. 102 (3), 551–553.

Walker AR, 2003. Ticks of domestic animals in Africa: a guide to identification of species 3-210. Bioscience Reports, Edinburgh.

Yilmaz AB, Deger S, Bulduk B, 2013. Prevalence of tick infestation on tortoise (testudo graeca, Linnaeus, 1758). YYU Vet Fak derg. 24 (2), 69-72.

Yilmaz AB, Kilinç Ö O, Adizel Ö, Bulum E, et al., 2018. Ticks collected from reptile species on Small Nemrut Mountain (Tatvan/Bitlis/Turkey). Med Weter. 74 (7), 445-448.