VETERINARIA ITALIANA
RIVISTA DI SANITÀ PUBBLICA VETERINARIA

Paper

First report of the hard tick Ixodes Ricinus on dogs in Lebanon

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Veterinaria Italiana, Vol. 59 No. 3 (2023) DOI: 10.12834/VetIt.2743.18431.2

Available on line: 31.03.2024

Abstract

Ixodes ricinus is a hard tick that can infest a large array of hosts. It is mostly abundant in the cool, humid deciduous and coniferous woods and forests of Europe. All *I. ricinus* life stages are potential vectors of many diseases, most notably Lyme disease, which affects millions of people yearly. Lebanon, an Asian Mediterranean country with mild cool winters and hot dry summers, lacks many reports concerning ticks. A study on tick abundance and identification on dogs presented to veterinary facilities, over the course of the years 2020 and 2021 was done. Several species of ticks were identified, with the least abundant being *I. ricinus*. To the best of our knowledge, this is the first report of the tick species in the country. More studies on the distribution and abundance of *I. ricinus* in Lebanon should be made in order to properly estimate the pathogens it carries, and consequently implement the appropriate prophylactic measures concerning public health.

Keywords

Ixodes ricinus, Lebanon, Mediterranean, First report, Distribution

Introduction

Ixodes ricinus, also known as the sheep, deer, or castor bean tick is a three-host tick predominantly found in Europe. Its geographical distribution ranges from 60 to 40° northern latitude (Schwarz A, 2009) and extends from northern Europe (Scandinavia) to the very northern part of Africa (Estrada-Pena, Bouattour, Camicas, & Walker, 2004; Erster, Roth, Hadani, & Shkap, 2013). *I. ricinus* ticks show typical questing behaviour in which they climb up vegetation and wait for passing hosts. Questing is dependent on temperature and humidity, increase in the temperature for a given relative humidity forces the ticks to descend to the moist vegetation to prevent desiccation and mortality (Perret, 2000).

I. ricinus is one of the most extensively studied tick species because of its wide range of host species and its role as a vector for various diseases and zoonoses (Estrada-Pena, Bouattour, Camicas, & Walker, 2004). It is the principal vector that transmits several viral, bacterial, and protozoan agents of medical and veterinary importance including babesiosis (Casati, Sager, Gern, & Piffaretti, 2006), anaplasmosis (Atkas, Vatansever, Altay, Aydin, & Dumanli, 2010), borreliosis (Gern L, 1997), and Tick-borne rickettsiosis (Welc-Falęciak, et al., 2014).

Ixodes ricinus is most frequently observed in coastal habitats and can be found on animals at much greater elevations up to 2000 meters above sea level (Rizzoli, et al., 2014). It is primarily associated with shrubs and deciduous and mixed forests, with a high abundance of small, medium, and large wild vertebrate hosts (Rizzoli, et al., 2014). Its habitat of choice are woodlands of oak with under tree covering, that receive at least 800 mm of rainfall yearly (Estrada-Pena, Bouattour, Camicas, & Walker, 2004; Lees, 1946).

Lebanon is a small, geographically diverse country with numerous microclimates, with an average annual rainfall of 800 mm (Verner, et al., 2018). It is characterized by a large range of forest vegetation and offers all typical vegetation levels of the Mediterranean region (Abi-Saleh, 1982). These conditions provide a suitable environment for reptiles,

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birds, and small and large mammals, which can act as potential hosts for *I. ricinus*.

Here, we report, for the first time, the existence of *I. ricinus* in Lebanon.

Material and Methods

Lebanon's Climate and Biodiversity

Lebanon is located on the eastern side of the Mediterranean basin, in western Asia at a latitude of 33.8547° N. The country has four seasons, which are typical of the Mediterranean region. Summers are hot and dry, and winters are cool and humid. The coast receives 600 to 800 mm of precipitation annually, the mountain ranges receive anywhere from 1000 to up to 2000 mm, the Beqaa plain between 200 to up to 1000 mm, and finally the South between 600 to 1000 mm (Farajalla, Haddad, Camargo, Lopes, & Vieira, 2014).

Being part of the Mediterranean basin, Lebanon is a natural hotspot for fauna and flora diversification. The country has more than 9000 species in total, distributed all throughout the different regions. It is rich in small animals like birds, invertebrates, as well as many Mediterranean terrestrial plants, both small and large (oak, madrone, juniper…) (Khoury, Antoun, & Abou Habib, 2016). Almost three quarters of the total surface area of Lebanon is mountainous. This diverse topography gives rise to many microclimates, favourable to the occurrence of many plant and animal species (ECODIT, 2012).

Tick Collection and Identification

Ticks were collected between January 2020 and December 2021, from dogs presented to various veterinary facilities across the country. Ticks were removed off from their hosts using fine tip forceps. They were then preserved in 70% ethanol in Eppendorf tubes.

Morphological identification

The samples were observed using digital stereo microscope. They were then identified according to a wide range of taxonomic keys (Nicholson et al. 2019, p. 603-618; Estrada-Peña et al. 2018; Bowman 2014; Farkas et al. 2013, p. 1-5; Roberts et al. 2013; Zajac and Conboy 2013; Estrada-Peña et al. 2004).

Results

Over the course of the 24 months, 536 dogs coming from various veterinary facilities across Lebanon were examined for ticks. A total of 1553 identified ticks were removed, of which 4 were *Ixodes ricinus* collected from 3 different hosts. The remaining ticks were divided into 863 *Rhipicephalus sanguineus*, 663 *Rhipicephalus turanicus*, 21 *Haemaphysalis parva*, 1 *Haemaphysalis erinacei*, and 1 *Hyalomma marginatum marginatum*.

The first collected *I. ricinus* was a male found on the 3rd of April in 2020 on the forelimb of a stray dog from Adma (Figure 1), which was found to have a mixed infestation with more than one tick species. The average monthly temperature and relative humidity in that location and at that time were 13°C and 58% respectively (World Weather Online, 2022).

The second specimen, an adult engorged female, was removed on the 23rd of March in 2021 from the neck of a dog located in Bouar (Figure 2). The average monthly temperature and relative humidity in that location and at that time were 9°C and 64% respectively (World Weather Online, 2022). The last 2 ticks were engorged nymphs that were collected on the 16th of June in 2021 from the abdomen of a dog that lives in Qornet Chahwan (Figure 3). The average monthly temperature and relative humidity in that location and at that time were 23°C and 55% respectively (Weather Atlas, 2022; Le Voyageur, 2022).

The locations of dogs from which the ticks were collected were the towns of Adma, Bouar and Qornet Chahwan. They all fall in the subhumid regions of Lebanon. Adma is located in coastal Lebanon, at an altitude of about 215 m above sea level, with an average annual precipitation of around 770 mm (World Weather Online, Adma Climate Weather Averages, 2022). Bouar is also located in coastal Lebanon, at an altitude of approximately 10 m above sea level, with an average annual precipitation of around 780 mm (World Weather Online, Bouar Climate Weather Averages, 2022). Qornet Chahwan is a suburban town in Mount Lebanon, at an altitude of around 680 m above sea level with an average annual precipitation of approximately 880 mm (Le Voyageur, 2022). All three locations have typical Mediterranean vegetation.

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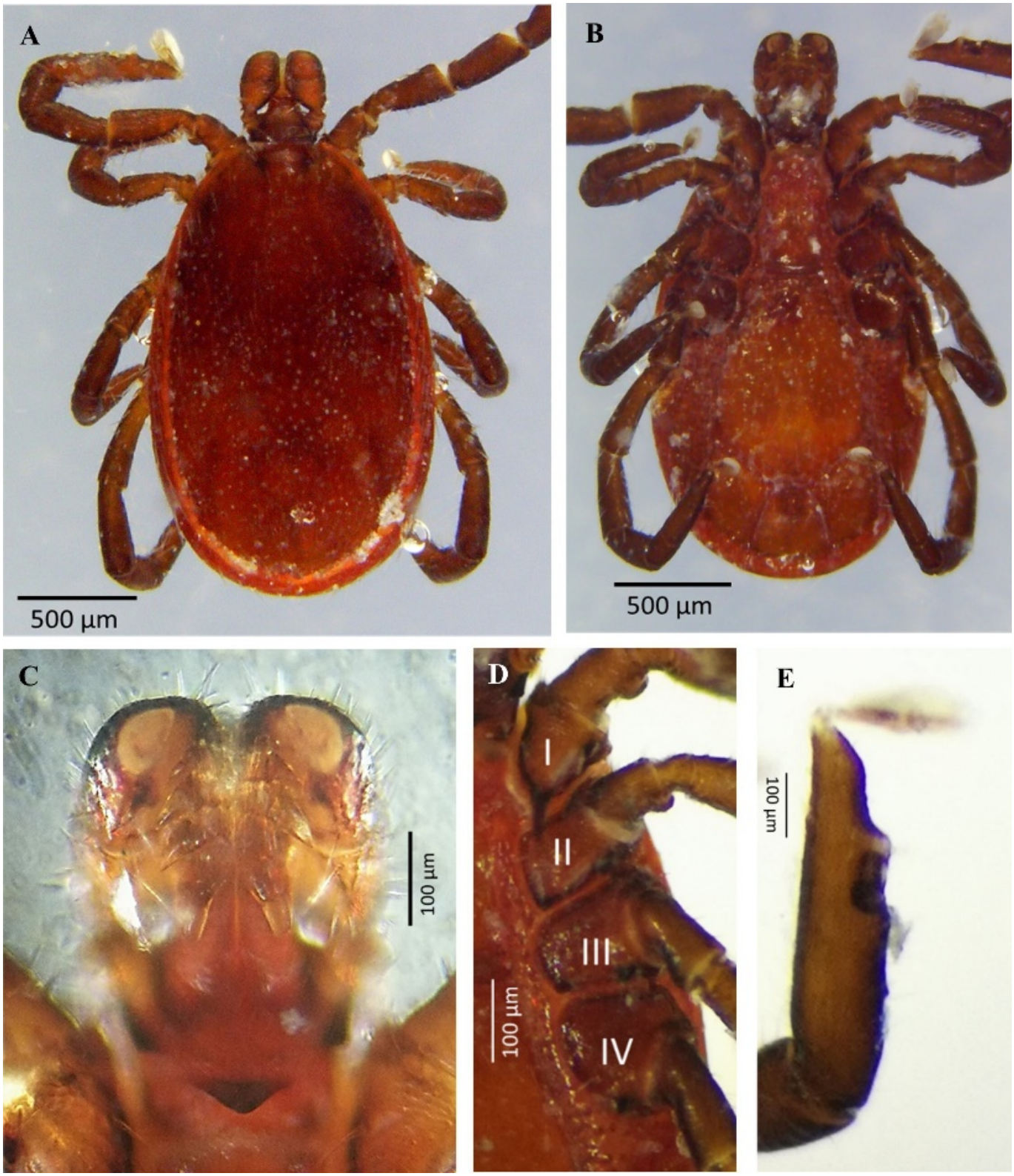

Figure 1. Morphology of the adult male I. ricinus found in Adma: Dorsal (A) and ventral (B) overview, ventral aspects of the basis of the capitulum (C), coxae I-IV (D), tarsus of the first pair of legs.

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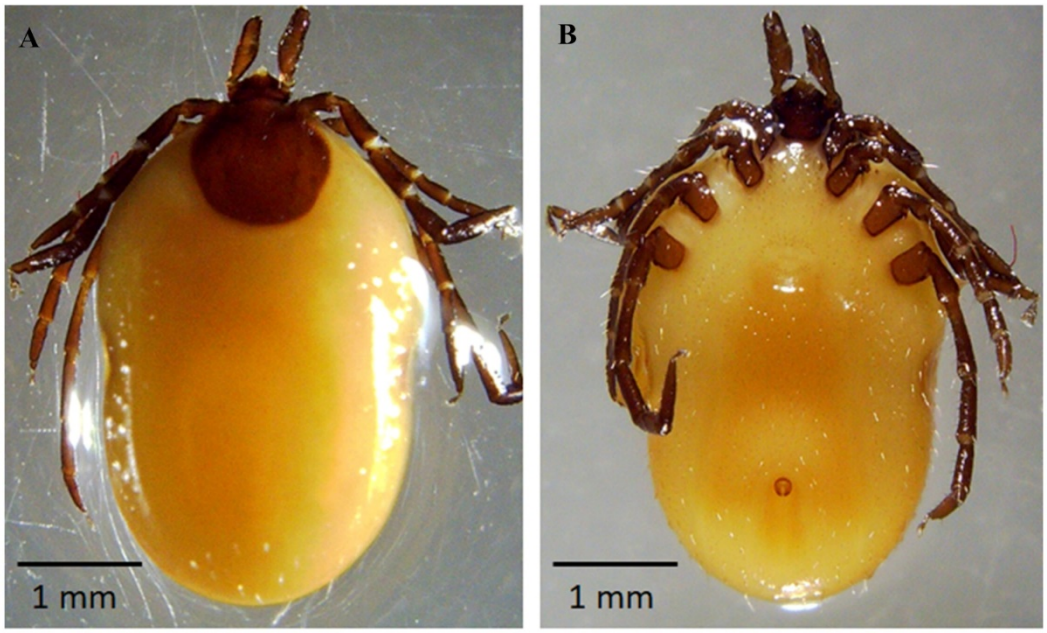

Figure 2. Morphology of the adult engorged female I. ricinus found in Bouar: dorsal (A) and ventral (B) overview.

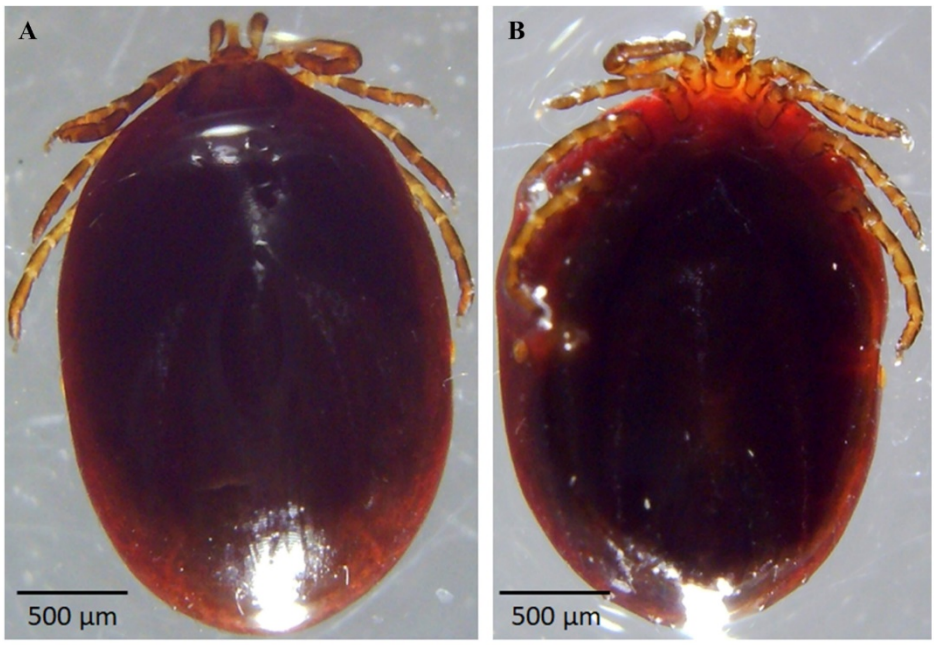

Figure 3. Morphology of the engorged nymph I. ricinus found in Qornet Chahwan: dorsal (A) and ventral (B) overview.

Discussion

To the best of our knowledge, this is the first report of *I. ricinus* in Lebanon. *I. ricinus* is widely distributed in Europe and its most common tick species (Trevor N. Petney, 2012). Its presence in the Mediterranean region and in Lebanon's neighbouring countries is relatively scarce. It was detected on goats in Mediterranean Turkey (Tunger, Mutlu, Karaer, Sayin, & Tunger, 2004; Inci, Yildirim, & Duzlu, 2016), on cats in Sicily, Italy (Pennisi, et al., 2015), on dogs in Greece, but only in the northern region (Latrofa, 2017). In addition, this species is reported in Palestine and in Southern Italy (Erster, Roth, Hadani, & Shkap, 2013; Dantas-Torres & Otrando, 2013). All these regions, as the three Lebanese collection sites, belong to the same Mediterranean climatic region, with comparable temperature and humidity. Obviously, this climatic region does not offer optimal conditions for the survival of *I. ricinus* and therefore the Mediterranean region is considered outside its biological predilection area (Estrada-Peña A., 1999). For *I. ricinus*

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survival within a habitat and for the completion of its life cycle, some important ecological pre-requisites are needed, like moderate to high rainfall, vegetation density that retains high humidity, and the presence of hosts for all active stages (Milne, 1949). Humidity is the main factor determining the distribution of *I. ricinus* and explains largely the relative absence of the species in many areas of the Mediterranean region (Gray, Kahl, & Zintl, 2021); it requires a relative humidity of at least 80% to survive during its off-host periods, which is above the average values (60%) at the time of the collections in the three collection sites. The vegetation in these sites is made up of typical Mediterranean vegetation shaded by larger trees; it consists of brushwood rather than forests where the mastic tree (*Pistacia lentiscus*) dominates and where the Palestinian oak (*Quercus calliprinos*) and the common myrtle (*Myrtus communis*) are relatively abundant (Abi-Saleh, 1982). All this constitutes a habitat with poor suitable vegetation and humidity. The presence of animals in these regions, such as reptiles, small rodents, small mammals, birds, stray dogs, and cats can serve as hosts for the various stages of *I. ricinus.* These ticks may have found in this relatively unsuitable environment an appropriate microclimate that was a vital factor for their survival. The amount of rainfall the towns receive annually is moderate, which may allow, in some regions with adequate vegetation, for the ground soil to stay moist under the shadow of large trees which creates a favourable microclimate where the ticks can hide and avoid dehydration (Medlock & et al., 2013). Such microhabitat can be found near rivers, irrigation canals, waterfalls or springs water that are widely distributed across Lebanon. It has been reported that questing of all stages is likely to continue in hot weather if the litter layer persists sufficiently moist (Gray, Kahl, & Zintl, 2021).

The collection of adults and instars of *I. ricinus* from more than one location and in different years, confirm that this species population is established in suitable regional patches in Lebanon. The role of migratory passerine birds should not be underestimated in the introduction and the dispersal of *I. ricinus* (Paulauskas A., 2009). The tick distribution in a zone is highly affected not only by vegetation and weather but also by host movements (Estrada-Peña A., 2003).

More studies needed to be done to determine the distribution of *I. ricinus* in Lebanon. This involves the collection of ticks from the environment by the tick dragging technique (Mejlon & Jaenson, 1997). Since adults spend approximately 70% of their time on the ground to restore their water balance (Mejlon & Jaenson, 1997), a thorough ground search, especially when the climate is not suitable enough for them to quest, would also result in a positive outcome. If further research is done, we expect to collect high numbers of *I. ricinus* specimens in locations with mixed forests and woods like Qornet Chahwan. Their numbers would be greatest in the cooler winter months, while large population of drought resistant deciduous oak trees, along with alder and pine trees, create favourable conditions for these ticks to survive during the warmer, drier months, as was seen in one study in Sweden (Jaenson & Lindgren, 2011). The detailed life cycle of the *I. ricinus* population found in the recently described habitat needs to be further investigated.

Of the 536 dogs included in this study, only 37 dogs were living at altitudes of 1000 meters and higher. It is interesting to check for tick distribution in these high altitudes as well. Although previously believed to have an altitudinal limit of around a few hundred meters, the species is now found at much higher altitudes. Due to climate change, the cold mountains have become warmer and able to harbour populations of this tick, as was seen in two studies in Czech Republic and Switzerland (Materna, Daniel, & Danielová, 2005; Lindgren, Tälleklint, & Polfeldt, 2000). A thorough search of the Mediterranean Lebanese forests in the mountain ranges could yield positive results yearlong.

The appearance of *I. ricinus* in Lebanon poses a new threat on public and animal health. The species is known to harbour and transmit a wide range of pathogens causing zoonoses. It is the major vector of Lyme disease caused by the bacteria *Borrelia burgdorferi* (Cotte, Bonnet, Cote, & Vayssier-Taussat, 2010). Lyme disease has never been previously reported in Lebanon; however, the existence of this important vector increases the risk of its circulation and justifies surveillance studies to monitor any potential circulation. *I. ricinus* can also transmit other disease such as *Rickettsiosis*, *Anaplasmosis*, *Ehrlichiosis*, and tick-borne encephalitis (Coipan, et al., 2013; Rizzoli, et al., 2014). Therefore, it is important to track down this tick species by determining its geographical spread and by assessing its vector potential in order to implement adequate prophylactic measures to protect both human and animal health.

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