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## Article

### A review of hard ticks (Acari: Ixodidae) in Colombia: The risk of tick-borne diseases

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#### ABSTRACT

This paper reviews the ixodid tick species that are present in Colombia. The different databases reported 50 species of ticks, of which 29 belong to *Amblyomma*: *A. auricularium*, *A. cajennense sensu lato (s.l.)*; for Colombia *A. calcaratum*, *A. coelebs*, *A. crassum*, *A. dissimile*, *A. geayi*, *A. goeldii*, *A. humerale*, *A. longirostre*, *A. maculatum*, *A. tigrinum*, *A. triste*, *A. mixtum*, *A. multipunctum*, *A. naponense*, *A. neumanni*, *A. nodosum*, *A. oblongoguttatum*, *A. ovale*, *A. pacae*, *A. pecarium*, *A. patinoi*, *A. rotundatum*, *A. sabanerae*, *A. scalpturatum*, *A. tapirellum*, *A. varium*, *A. incisum*, *A. parvum*; two *Haemaphysalis* species: *H. juxtakochi*, *H. leporispalustris*, two *Rhipicephalus* species: *R. (Boophilus) microplus*, *R. sanguineus s.s.*, two *Dermacentor* species: *Anocentor (D.) nitens*, *D. imitans*, and 15 species of *Ixodes*: *I. affinis*, *I. andinus*, *I. auritulus*, *I. bocatorensis*, *I. boliviensis*, *I. brunneus*, *I. fuscipes*, *I. lasallei*, *I. loricatus*, *I. luciae*, *I. montoyanus*, *I. pararicinus*, *I. tapirus*, *I. tropicalis*, *I. venezuelensis*. Some of these species need to be validated, their presence confirmed, and their role as a risk for human and animal health studied. Therefore, a countrywide survey of Ixodidae ticks would be of great value to update the information presented in this work.

**KEY WORDS:** America; biodiversity; checklist; health; Ixodida; vector.

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#### INTRODUCTION

Colombia is located between Central America and Equatorial South America, with different ecosystems (habitats and biotypes). Colombia is the fifth country with the most diversity of mammals in the world, after Indonesia, Brazil, Peru, and Mexico (Rodríguez-Maecha *et al.* 2006).

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About 40% of this natural richness is located in the Andes (Alberico *et al.* 2000; López-Arévalo and Montenegro-Díaz 1993). This location is suited to study biodiversity and ecological changes of Ixodidae ticks in humid tropical forests, premontane pluvial forests in warm transition, dry and very dry tropical forests as well as in lowland montane and pluvial montane forests (Gómez *et al.* 2007). These variables and environmental conditions may suggest that all the tick species described in the Neotropical region are present in Colombia (Lopez 2017). Unfortunately, few studies have dealt with the presence of Ixodidae in Colombia. In one of the most influential studies, Osorno-Mesa (1942) published the first taxonomic key for identification of *Amblyomma* species in Colombia and Panama. The most relevant study regarding wild animals was developed by Wells *et al.* (1981); they surveyed domestic and wild animals in the Llanos Orientales (Eastern planes) describing *A. cajennense s.l.*, *A. auricularium*, *A. rotundatum*, *A. maculatum*, *A. longirostre*, *A. pacaе*, *Ixodes luciae* and *Rhipicephalus (Boophilus) microplus* (Wells *et al.* 1981); after that, most researchers have focused on domestic animals and rarely on wild fauna, limiting the knowledge of Colombia's biodiversity. Nevertheless, 43 species of Ixodidae and 15 Argasidae have been reported in Colombia (Rivera-Paez *et al.* 2018a).

Unfortunately, there are no collections or repositories in Colombia that would enable comparisons of the species between areas, in addition to allowing a better understanding of the ticks' geographic and ecological distribution, and their role as disease vectors for humans and animals. Most Colombian ticks are deposited in multiple International Collections, the Colombian Institute of Tropical Medicine of the CES University (officially Corporation for studies in health), a collection donated by Dr. Gustavo Lopez, and the recently created collection at the National University of Colombia, Palmira, Colombia (CEUNP) as well as another one in University of La Salle.

## MATERIALS AND METHODS

This review is based on previous studies conducted by Osorno-Mesa (1942) and studies carried out by Dr. Eric Wells, Dr. Guillermo Mateus, Dr. David Evans, Dr. Gustavo Lopez Valencia, Dr. Antonio Betancourt, Dr. Luis Enrique Paternina, in addition to recent articles published by different authors on scientific databases regarding “Hard Ticks of Colombia” and “Tick-borne diseases”. The most recent scientific-literature on ticks has been incorporated, following original descriptions of valid tick names or synonyms in Guglielmone's research retrieved from <http://rafaela.inta.gob.ar/nombresgarrapatas/>; the tick collection of the Instituto Nacional de Tecnología Agropecuaria (INTA) at Rafaela, Argentina; digital resources in the Global Biodiversity Information Facility and Catalogue of Life databases (<https://www.gbif.org/species/>, [www.catalogueoflife.org/col](http://www.catalogueoflife.org/col)). We included Google Scholar search results (<https://scholar.google.de/>), ResearchGate, Scopus (<https://www.scopus.com/>), ProQuest, JSTOR, Gale databases, and EBSCO, and the Sinab from National University, including theses and short communications. Unfortunately, most of the reports do not describe the locality or host. The specimens are not deposited in any Entomological or tick collection in Colombia and most of them lay in international institutions that restrict or limit morphological examination and tick comparison. Some of the recorded species may present a threat for human and animal health; therefore, it would be of great value to make a countrywide survey of ticks in order to update the information presented in this work. Figures are not to scale.

## RESULTS

In this study, we found 50 species of Ixodidae, from which 29 are *Amblyomma*, two *Haemophysalis* spp., two *Rhipicephalus* spp., two *Dermacentor* spp. and 15 *Ixodes* spp. We described all of them in

terms of endemicity, establishment or just reported. Some examples of ticks identified in Colombia are included in this review.

### **The genus *Amblyomma* Koch, 1844**

The genus *Amblyomma* is represented by 106 species in the world, 59 of which are present in the Neotropical region, with 47 being exclusive to this location; 11 are present in the Nearctic region, and just one is not native of America (Barros-Battesti *et al.* 2006). Specifically, 31 *Amblyomma* species have been reported in Colombia (Lopez 2017), but according to scientific databases and new systematic classification, the list is updated to 29 *Amblyomma* species including: *A. auricularium* (Conil, 1878), *A. calcaratum* Neumann, 1899, *A. coelebs* Neumann, 1899, *A. crassum* Robinson, 1926, *A. dissimile* Koch, 1844, *A. geayi* Neumann 1899, *A. goeldii* Neumann 1899, *A. humerale* Koch, 1844, *A. incisum* Neumann, 1906, *A. longirostre* (Koch, 1844), *A. maculatum* Koch, 1844, *A. mixtum* Koch, 1844, *A. multipunctum* Neumann, 1899, *A. naponense* (Packard, 1869), *A. neumanni* Ribaga, 1902, *A. nodosum* Neumann, 1899, *A. oblongoguttatum* Koch, 1844, *A. ovale* Koch, 1844, *A. pacae* Aragão, 1911, *A. parvum* Aragão, 1908, *A. patinoi* Labruna, Nava & Beati 2014, *A. pecarium* Dunn, 1933, as well as, *A. rotundatum* Koch, 1844, *A. sabanerae* Stoll, 1894, *A. scalpturatum* Neumann, 1906, *A. tapirellum* Dunn, 1933, *A. tigrinum* Koch, 1844, *A. triste* Koch, 1844, *A. varium* Koch, 1844.

#### ***Amblyomma auricularium* (Conil, 1878)**

This tick has been found in Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, French Guiana, Guatemala, Honduras, South of Mexico, Nicaragua, Panama, Paraguay, Trinidad and Tobago, Uruguay and Venezuela, (Onofrio *et al.* 2006; Lopez 2017). It feeds on *Xenarthra* species, especially on armadillos (Guglielmone *et al.* 2003). In Colombia, it has been reported on Dasypodidae, *Dasypus novemcinctus* (Armadillo) and *Canis familiaris* in San Marcos, Department of Sucre (Contreras Ortega 2016; Lopez 2017). The importance of this species, in relation to its biology and ecology, is yet to be studied.

#### ***Amblyomma cajennense* (Fabricius, 1787)**

These ticks are distributed from Argentina to Southern Texas (U.S.A) with the exception of Chile and Uruguay, where they have not been confirmed, as well as in the Caribbean and the Nearctic region (Barros-Battesti *et al.* 2006). Species of *Amblyomma cajennense s.l.* are probably one of the most threatening plagues to cattle farms considering their physical damage potential, natural biological cycle and the likelihood of immature stages being dispersed by birds and wild and domestic mammals as well as their vector capacity to transmit different rickettsia species in South America. They are widely distributed and able to feed on a wide range of mammals, humans and birds (Guglielmone *et al.* 2006; Lopez 2017). *Amblyomma cajennense s.l.* comprises six species: 1. *A. cajennense sensu stricto (s.s.)* (Fabricius, 1787), 2. *A. interandinum* Nava *et al.*, 2014, 3. *A. mixtum* Koch, 1844, 4. *A. patinoi* Nava *et al.*, 2014, 5. *A. sculptum* Berlese, 1888, and 6. *A. tonelliae* Nava *et al.*, 2014 (Nava *et al.* 2014; Martins *et al.* 2016). These species are geographically distributed as follows: *A. cajennense s.s.* is restricted to Amazon regions; *A. mixtum* has been located from Texas to western Equator; *A. sculptum* is restricted to north Argentina, Bolivia, Paraguay and Brazil; *A. interandinum* (Nava *et al.* 2014) is restricted to inter-Andean valley of Peru; *A. tonelliae* (Nava *et al.* 2014) is indigenous to dry areas of north Argentina, Bolivia and Paraguay; and *A. patinoi* (Nava *et al.* 2014) is found in the Eastern Cordillera of Colombia (Beati *et al.* 2013; Nava *et al.* 2014; Lopez 2017). In Colombia, the species of *A. cajennense s.l.* are specifically represented by two species: *A. patinoi* Labruna, Nava & Beati, 2014, which can be

found in the Eastern Andes of Colombia, and *A. mixtum*, which is distributed from Texas (U.S.A) to western Ecuador. *A. cajennense s.l.* seems to thrive in the lowlands (average: 472.9 m a.s.l.), but its populations can also be found up to 1,771 m a.s.l. (Acevedo-Gutiérrez LY *et al.* 2018).

### ***Amblyomma cajennense s.l.***

In Colombia, there are widespread reports of its presence in horses, cattle, and humans (Reyes 1938). There have been reports of its presence in Valle del Cauca from cattle and horses (Benavides *et al.* 2018), in cattle from Monteria, Arboletes, Tolúviejo, Cauca (West of Córdoba) (Betancourt *et al.* 1992) in Tolúviejo, Sincelejo and San Marcos, Department of Sucre (Contreras Ortega 2016) and the Piedemonte (Foothills) of Meta and Casanare, in the Eastern Planes (Cassalett *et al.* 2013). Regarding this, it is interesting to see that Betancourt *et al.* (1991) did not find any *A. cajennense s.l.* in cattle in Tumaco. Future local comparative studies are required in order to clarify the identity of the species of *Amblyomma*. reviewed until now, as it is unclear if it is *A. cajennense s.l.* In different entomological and tick collections of Colombia, the species frequently identified as *A. cajennense s.l.* might be composed of *A. patinoi* and/or *A. mixtum*; hence there is need for future studies in different geographical regions of Colombia. In a study conducted in six departments of Colombia (Antioquia, Atlántico, Bolívar, Córdoba, Magdalena, and Sucre), 3,308 ticks were collected including *A. cajennense s.l.*, *A. ovale*, *R. microplus* and *D. nitens*, in which *Rickettsia rickettsii*, *R. bellii*, *R. felis*, *Candidatus Rickettsia colombianensi* and *R. parkeri* were found. A total of 649 animals were sampled for the presence of Rickettsiae. Among them, 18% were found positive (117/649) for *R. rickettsii*, *R. amblyommatis* and *R. bellii* (Acevedo-Gutiérrez *et al.* 2017).

### ***Amblyomma calcaratum* Neumann, 1899**

This tick has been recorded in Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, French Guiana, Panama, Paraguay, Trinidad and Tobago, Surinam and Venezuela (Jones *et al.* 1972; Onofrio *et al.* 2006; Voltzit 2007; Lopez 2017). The larval and nymphal stages have been found on birds. In Colombia, it has been reported on *Tamandua tetradactyla* (anteater) and on *C. lupus familiaris* from Chocó (Reyes 1938; Wramc 1998; Onofrio *et al.* 2006; Lopez 2017). Similar to southern Mexico and other countries (Guglielmone *et al.* 2003; Guzmán-Cornejo *et al.* 2006), this tick is a vector of *Rickettsia* sp. and *R. parkeri* (Ogrzewalska *et al.* 2013; Lopez 2017). Adults of this species have been deposited at the Zoologische Museum Hamburg, Germany (ZSH), Muséum national d'Histoire naturelle, Paris, France (MNHN), and The Natural History Museum, London, England (BMNH) (Onofrio *et al.* 2006). This tick requires further research in order to better understand its associations with tick-borne diseases as well as to improve the available information regarding its geographical distribution; it is not known if this species is a vector of *Rickettsia* in Colombia.

### ***Amblyomma coelebs* Neumann, 1899**

It is present in Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Guatemala, Guaiana, French Guiana, Honduras, south of Mexico, Nicaragua, Panama, Paraguay, Peru, Surinam and Venezuela (Nearctic region) (Onofrio *et al.* 2006). *Amblyomma coelebs* feeds on Perissodactyla, more often on tapirs, and has been collected in almost every country in Central and South America, from southern Mexico to Argentina, with the exception of Chile and Uruguay (Jones *et al.* 1972; Guglielmone *et al.* 2003). There have been reports in Brazil about adults and nymphs feeding on humans (Guglielmone *et al.* 2006). A nymph, molecularly identified as *A. coelebs*, was recently collected from a man who had traveled to Guyana (Beati, unpublished data), but it has also been identified on tapirs whereas nymphs use a different host in order to survive (Labruna and

Guglielmone 2009; Martins *et al.* 2014). It was reported that *Candidatus Rickettsia amblyommii* is present in this species, probably associated with animal infections in Brazil, Argentina and French Guiana (Parola *et al.* 2013). In Colombia, this species has been spotted on cattle, capybaras (*Hydrochoerus hydrochaeris*) and anteaters (Lopez Valencia and Parra Danilo 1985; Lopez 2017).

#### ***Amblyomma crassum* Robinson, 1926**

It has been reported parasitizing reptiles in Colombia, Peru, and Venezuela, (Jones *et al.* 1972; Onofrio *et al.* 2006; Voltzit 2007). Females of this species have been collected in Colombia from *Geochelone denticulata* (*Testudo tabulata*), which are also known as Morrocoy (Wramc 1998). In Colombia, females removed from these tortoises were originally described by Robinson (1926). This researcher collected them in the Darien department of Chocó; today, the sample is deposited in the RML Rocky Mountain Laboratories (Gray 1861; Méndez and Ortíz 1957; Garcés-Restrepo *et al.* 2013b). Subsequently, it was also reported in Venezuela, Peru, Panama and Costa Rica (Amorim *et al.* 2013) as well as on river turtles from Villavicencio (Meta department) by Osorno-Mesa; however, there was no characterization based on the sex of the specimens (Osorno-Mesa 1942; Méndez and Ortíz 1957). Méndez and Ortíz conducted an expedition to the Orinoco Delta and collected two males and four females from Morrocoy (*Testudo* sp.). These samples were deposited in the Museo de Historia Natural de la Salle (Méndez and Ortíz 1957).

#### ***Amblyomma dissimile* Koch, 1844**

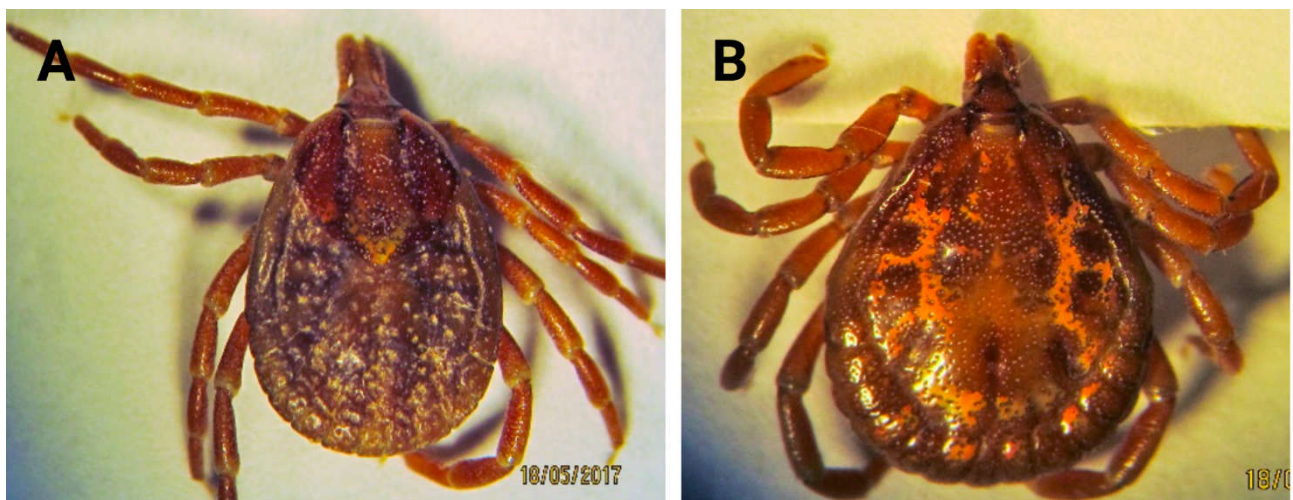
Syn.: *A. bibroni* Gervais, 1842 (a nomen nudum)

It is a three-host tick (Hooker *et al.* 1912) reported in Antigua, Argentina, Barbuda, Barbados, Belize, Brazil, Colombia, Costa Rica, Cuba, Dominican Republic, El Salvador, Ecuador, French Guiana, Guaina, Guadeloupe, Guatemala, Grenada, Haiti, Honduras, Jamaica, south of Mexico, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Santa Lucia, Trinidad and Tobago, and Venezuela (Onofrio *et al.* 2006). All the stages parasite different reptiles (snakes, lizards, iguanas, alligators and turtles) and amphibians (toads) (Durden and Knapp 2005; Guglielmone *et al.* 2009). This tick attacks several species of cold-blooded vertebrates, showing no host preference; however, it is commonly found on *Bufo marinus* (Bequaert 1932). Toads and iguanas are also commonly infested (Guimarães *et al.* 2001; Guglielmone *et al.* 2003; Dusbabek 2004). In Colombia, the species has been previously identified as *A. diminutivum*, equivalent of *A. dissimile* (Santos Dias 1958) as well as by the name of *Ixodes bibroni* (Gervais, 1842). However, Aragão and Fonseca (1961) preferred to label it as *A. dissimile*. In Brazil, it has been reported on *Boa constrictor* (*Hydrodynastes gigas*) (Fontana 2003; Fiorini *et al.* 2014), on Blue-winged macaw (*Primolius maracana*), in areas that host free-living iguanas (*Iguana iguana*) (Schumaker and Barros 1994; Scofield *et al.* 2011), *Xenodon* sp. (Schumaker and Barros 1994), on mammals such as *Hydrochoerus hidrochaeris*, Rodentia (*Proechimys semispinosu*), cattle (*Bos taurus*) (Jones *et al.* 1972) as well as goats in experimental models (Jongejan 1992). In Colombia, this tick is commonly associated with reptiles and amphibians such as *Iguana tuberculata*, *B. marinus* and snakes from Santa Marta–Barranquilla collected from *Boa imperator*, *Boa enydris cookei*; in Aracataca (Magdalena), it has been collected from *B. marinus*, *Caiman sclerops* and *Constrictor constrictor* (Wramc 1998), from *Boa constrictor* (Carrascal *et al.* 2009), and *Bothrops asper* (Wramc 1998). Five ticks were collected from Mulatos in the municipality of Turbo, Antioquia (8° 08' 12.5" N, 76° 33' 01.7" W), and Las Chingas in the municipality of Necoclí (8° 32' 52.5" N, 76° 34' 23.7" W). One of these Mulatos was hosting a tick infected with *Candidatus Rickettsia colombianensi* (Quintero *et al.* 2017b), which is endemic in Valle del Cauca (Lopez 2017). Benavides *et al.* (2018) reported *Amblyomma dissimile* from *B. asper* in San Cipriano (Valle del Cauca, 76° 54' 041" W, 3°

50° 32.1" N, located at 149 m a.s.l.) in a wet tropical rain forest (Galli 1927; Guglielmo *et al.* 2006) deposited in CIUNP (Accession Nos. 002-1, 002-2) (Benavides-Montaño *et al.* 2018). *Amblyomma dissimile* removed from iguanas and rodents have been found positive to *Rickettsia tamurae*, which produces local skin inflammation, swelling, erythema, and heat with pain in humans (Fournier *et al.* 2006; Miranda *et al.* 2012; Quintero *et al.* 2013; López and Parra 2017). Tick samples collected from *Rhinella humboldti* (Spix, 1824) and *Rhinella marina* (Linnaeus, 1758) in Santa Marta, Magdalena were positive to *Rickettsia* close related with *Rickettsia* sp. strain *colombianensis* and *R. belli* (Cotes-Perdomo *et al.* 2017; Santodomingo *et al.* 2018) and new reports confirm its presence in Yopal, Casanare department (Rivera-Paez *et al.* 2018a) associated with *Rickettsia* sp. strain *colombianensis* (Rivera-Paez *et al.* 2018b) as well as microorganisms of Anaplasmataceae in ticks collected from reptiles (Osorio *et al.* 2017), *R. amblyommatis* and *Cand. R. colombianensis* (Quintero *et al.* 2017a).

### *Amblyomma geayi* Neumann, 1899 (Fig. 1)

Present in Brazil, Colombia, Guiana, French Guiana, Panama, Peru, and Surinam. Reported from mammals of the Xenarthra order such as sloths (Onofrio *et al.* 2006). It also has been reported in *Caluromys* (Opossum) (Wramc 1998). The original male ticks were collected by Fort Sherman in the Darién Gap, in the border between Panama and Colombia (Osorno-Mesa 1942). It is found primarily on mammals and wild birds from tropical regions in South America such as sloths *Bradypus variegatus* (Souza *et al.* 2016), but also reptiles and amphibians. *Amblyomma geayi* is closely-related morphologically, genetically and ecologically to *A. longirostre* and *A. parkeri* and the immature stages are considered to feed on Passeriformes (Labruna *et al.* 2009; Ogrzewalska *et al.* 2010). The distinctive feature of this species is that the Coxa I has short, robust and rounded spikes; the internal spike is very small (Barros-Battesti *et al.* 2006). In Colombia, there are three species of Sloths/Perezosos reported: one of three nails (*Bradypus variegatus*) and two of two nails (*Choloepus hoffmanni* and *Choloepus didactylus*) (Wetzel 1985). The habitat of these species is determined by the availability of continuous vegetation cover and bioclimatic factors (Moreno and Plese 2005). The range of *Bradypus variegatus* occupies almost the entire national territory; today it is zone-bound to some coastal regions, some low localities of the Inter-Andean Valleys and regions between the Orinoco and the Amazon (Wetzel 1985; Phillips *et al.* 2006). *Amblyomma geagy* has also been reported in Colombia on *C. didactylus* (Lopez 2017).



**Figure 1.** *Amblyomma geagy* – **A.** Dorsal habitus of female; **B.** Dorsal habitus of male. Source: GLV.

### ***Amblyomma goeldii* (Neumann 1899)**

It has been described in Brazil, French Guiana, Surinam, Guyana, Colombia and Jamaica (Robinson 1926; Jones *et al.* 1972; Voltzit 2007; Ogrzewalska *et al.* 2010; Martins *et al.* 2015; Soares *et al.* 2015). This tick was originally named as *Ixodes gervaisii* and considered to be an exclusive reptile tick (Guglielmone *et al.* 2010). It was often misidentified as *A. rotundatum* in the early literature (Voltzit 2007). New records have shown association with anteaters (Pilosa: Myrmecophagidae); toads and snakes are the main hosts for adult and nymph stages. *A. goeldii* can be miss-identified with *A. romitii* Tonelli-Rondelli 1939, *A. dissimile*, and *A. rotundatum* (Martins *et al.* 2015). The geographical distribution of *A. goeldii* appears to be restricted to the Amazonian region, where males and females have been described (Onofrio *et al.* 2006; Martins *et al.* 2015). In Venezuela, its presence was associated with *B. marinus* in San Fernando de Atabapo, Bio Orinoco (Jones *et al.* 1972); and in Brazil, State of Amazonas, with *Tamandua tetradactyla* (Ogrzewalska *et al.* 2010). There is just one report in Colombia, an adult female, collected from a toad (big) in Condoto by Dr. Spurrel H.F.G in 1913 (Osorno-Mesa 1942); this report needs to be replicated, updated and clarified (Robinson 1926; Keirans and Nuttall 1985). New studies are required in order to understand its bio-ecology and distribution areas.

### ***Amblyomma humerale* (Koch, 1844)**

This tick is found in Bolivia, Brazil, Colombia, Ecuador, Guiana, French Guiana, Guyana, Surinam, Perú, Trinidad and Tobago, Venezuela (Onofrio *et al.* 2006). It has been found on birds, lizards, opossums, anteaters, yellow-footed tortoise (*Geochelone denticulate*), rodents (*Oryzomys capito* and *Proechimys guyannensis*) and dogs (Labruna *et al.* 2002). Usually, the hosts for adults of *A. humerale* are reptiles of the order Testudines, but mammals such as dogs have also been found parasitized by immature stages (Barros-Battesti *et al.* 2006; Onofrio *et al.* 2006). In Colombia, it has been reported on turtles (*Helonoides testiculata*) (Wramc 1998; Lopez 2017). New updates, geographic distribution, ecology, and pathogenic role in humans are required.

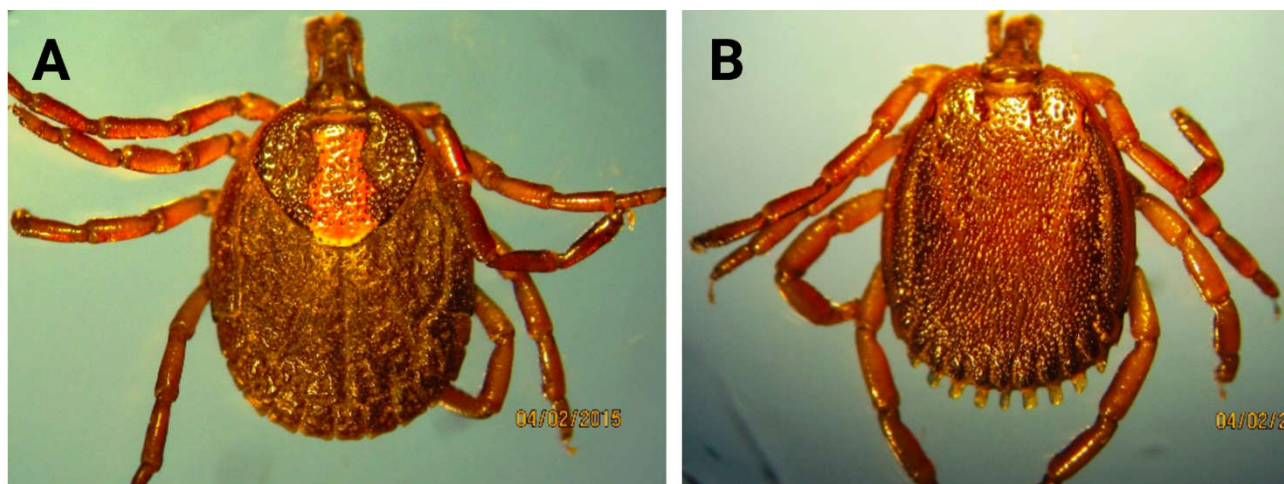
### ***Amblyomma incisum* Neumann, 1906 (Fig. 2)**

It is distributed in Argentina, Bolivia, Brazil, Ecuador, French Guiana, Paraguay, Peru, Venezuela (Onofrio *et al.* 2006; Lopez 2017). The main host is Perissodactyla, but it is also found on *C. lupus familiaris* and capybara (Onofrio *et al.* 2006). In Colombia, there have been reports of *A. incisum* on monkeys in San Juan de Arama, Meta, and also on *Tapirus terrestris* and *Myrmecophaga tridactyla* (Lopez 2017). In Colombia, no updates have been made recently, but considering that *A. incisum* population is highly dependent on a forest-like environment, and it is disseminated in the Atlantic Forest of Brazil on tapir – the main host for adult ticks, and the fact that rabbits and horses are suitable hosts for larvae and nymphs (Szabo *et al.* 2009), this tick might have a notorious distribution in Guainia, Vaupes and Amazonas (Colombia departments).

### ***Amblyomma longirostre* (Koch, 1844)**

This species is endemic in South America; its presence has been reported in Argentina, Bolivia, Brazil, Colombia, French Guayana, Guyana, Panama, Paraguay, Peru, Surinam, Trinidad y Tobago, Uruguay, Venezuela (Barros-Battesti *et al.* 2006; Onofrio *et al.* 2006; Lopez 2017). Nymphs parasitize passeriform birds and the adults infest rodents such as *Coendou* sp. and *Sphigurus* sp. (Onofrio *et al.* 2006). In Colombia, it has been reported on a porcupine *Cercolabes prehensilis* that came from Boyacá (Osorno-Mesa 1942), but there are no new updates. *Amblyomma longirostre* is a species whose adults mainly parasite rodents of the Erethizontidae family, including the porcupines

*Coendou prehensilis*, although occasionally it has also been found on monkeys of the genus *Cebus*, cappuccino monkey, and on humans (Lopez 2017). The nymphs have been found feeding on frugivorous bats *Artibeus* spp., rodents *Sciurus* spp. as well as in a wide variety of birds in Central America, South America and the United States ( Venzal *et al.* 2005; Rodríguez-Peraza *et al.* 2014; Lopez 2017). Rickettsiae like *R. belli*, *R. parkeri* and *R. amblyommii* have been found in this tick in Latin America (Labruna *et al.* 2004; Noden *et al.* 2015). However, there is no new information regarding their presence in Colombia.



**Figure 2.** *Amblyomma incisum* – A. Dorsal habitus of female; B. Dorsal habitus of male. Source: GLV.

### *Amblyomma maculatum* Koch, 1844

The *Amblyomma maculatum* group formerly included *A. tigrinum* Koch, 1844, *A. triste* Koch, 1844, *A. maculatum*, *A. neumanni* and *A. parvitarsum* Neumann, 1901. *Amblyomma maculatum* has often been confused with *A. triste* and *A. tigrinum* (Volzitz 2007). After new morphological and molecular studies, this group was reduced to *A. maculatum*, *A. triste* and *A. tigrinum* (Estrada-Peña *et al.* 2005). *Amblyomma tigrinum* is present in every South American country, except for Colombia, Ecuador, Guyana, and Surinam (Jones *et al.* 1972). *Amblyomma maculatum* occurs no farther south than Colombia and Venezuela, and the most southern records of *A. maculatum* from canids are in every case *A. tigrinum* (Aragão 1918; Kohls 1956). Both species are at first glance similar, but adults of *A. maculatum* possess a pair of spurs distally on the metatarsi of legs II, III and IV, whereas in adults of *A. tigrinum* only a single spur occurs on these metatarsi. This tick is a Neotropical-Nearctic species with *bona fide* records from Belize, Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Mexico, Nicaragua, Peru, the U.S.A., and Venezuela (Onofrio *et al.* 2006; Mastropaolo *et al.* 2014). It is known as “gulf coast ticks”; it is a three-host tick that has been reported throughout the Americas and in some of the islands of the Caribbean basin. The adults parasitize different mammals, primarily ruminants, dogs, deer, coyotes, foxes. It is considered an aggressive, human and animal-biting ixodid tick (Bishopp and Hixson 1936). The immature stages feed on a variety of birds but occasionally use small mammals as hosts (Guglielmone *et al.* 2003; Teel *et al.* 2010; Voltzitz 2007). Infested livestock often experience decreased body weight, irritation and/or secondary infection. *Amblyomma maculatum* is a potential vector of human pathogens such as *Ehrlichia ruminantium* (Bram *et al.* 2002; Mahan *et al.* 2000), *R. parkeri* (Sumner *et al.* 2007; Paddock *et al.* 2008; Socolovschi *et al.* 2009). In Colombia, *A. maculatum* has been reported on cattle, horses, dogs, birds, and rodents ( Wramc 1998; Lopez 2017). It was previously reported in the Eastern Plains (Llanos Orientales) (Wells 1975; Wells *et al.* 1981b) with ticks sent by Dr. Luis Patino-Camargo to Dr. Gadow H and donated to the Rocky Mountain Laboratory (Robinson 1926).

The presence of R.M.S.F. agent (*R. rickettsii*) in 1935 was previously associated with *Dermacentor nitens* and *A. cajennense* ticks collected from horses, horse saddles and mule dresses, and *Rhipicephalus sanguineus* from dogs (Patino *et al.* 1937; Hidalgo *et al.* 2007). New reports of *Rickettsia* spp. in Colombia confirm its presence on dogs from the Caldas, Ibaguè and Tolima departments (Rivera-Paez *et al.* 2018a), *A. nitens* in Valle del Cauca, *A. cajennense*, *Ixodes* spp., on *Equus caballus* and *E. asinus* in Peñas Gordas/Dagua (3° 46' 34.8" N), (76° 43' 05.3" W) at 345 m a.s.l. (Benavides-Montaño *et al.* 2018) deposited on CEUNP (008-009) (Benavides-Montaño *et al.* 2018), on dogs and horses in Santander, Cattle in Tolima, and Zarigüeya Lanuda *Caluromis derbianus* - *Marmosa alstoni* in Valle del Cauca. Efrain Benavides reported the presence of *A. maculatum* (three females and six males) from rural areas of Anapoima, Fusagasugá, Tocaima and Ricaurte in tropical dry forest - Interandean Valles (Benavides *et al.* 2017a). This tick was recently reported as a vector of *Candidatus R. andeanae* in ticks collected from *C. lupus familiaris* in Ibaguè (Rivera-Paez *et al.* 2018b).

### *Amblyomma mixtum* Koch, 1844 (Fig. 3)

This species has been collected from *Bos taurus*, *Equus asinus*, *Equus caballus* and vegetation in five different locations of Colombia: Arauca; Nunchía, Casanare; Yopal, Casanare; San José de Arama, Meta; and Neira, Caldas (Rivera-Paez *et al.* 2016,2018b), but it has also been described in the Pacific and Caribbean regions (Estrada-Peña *et al.* 2014). In the Orinoquía region, *Amblyomma mixtum* is considered the main vector of *R. rickettsii*, the agent that causes R.M.S.F. or Tobia's disease fever, and *R. amblyommii* (Nava *et al.* 2014; Rivera-Paez *et al.* 2016). *Amblyomma mixtum* has been described as a vector of *R. rickettsii* in Central America (Rivera-Paez *et al.* 2016). Recently, this tick was reported as positive for the presence of *R. rickettsii* in specimens collected from *Bos taurus*, *E. caballus*, *Canis lupus familiaris* in Arauca and Yopal (Casanare), *Rickettsia* sp. strain *colombianensis* in Yopal (Casanare) (Rivera-Paez *et al.* 2018b), and *Rickettsia* sp. in ticks collected in Santa Marta (Miranda *et al.* 2017).



**Figure 3.** *Amblyomma mixtum* – A. Dorsal habitus of female; B. Dorsal habitus of male. Source: GLV.

### *Amblyomma multipunctum* Neumann, 1899

This species is present in Bolivia, Colombia, Ecuador, and Venezuela (Onofrio *et al.* 2006; Labruna *et al.* 2013). It parasitizes mammals of the order Perissodactyla. Adults and nymphs of *A. multipunctum* are found in highland, humid montane forest, and páramo areas, between 2,000 and

4,000 m a.s.l. (Onofrio *et al.* 2006; Labruna *et al.* 2013). In Colombia, Kohls (1956) reported two males and two females of *A. multipunctum* from a mountain tapir, and *Tapirus pinchaque* (Roulin) in Loro River on the border of the Huila, Meta and Caqueta departments, in November of 1967 (US National Tick Collection, RML 49127) (Voltzit 2007; Lopez 2017).

### ***Amblyomma naponense* (Packard, 1869)**

It is distributed in Bolivia, Brazil, Colombia, Costa Rica, Ecuador, Guyana, French Guiana, Panama, Peru, Surinam and Venezuela (Onofrio *et al.* 2006). It parasitizes ungulates and Xenarthra (Onofrio *et al.* 2006; Voltzit 2007). This species has been reported on peccary, *Pecari angulatus bangsi*, from Rio Boquerón, a region from Panama (Osorno-Mesa 1942). In Colombia, it has been found in the Raposo river (Buenaventura-Valle del Cauca) parasitizing *Heteromys australis* (spiny pocket mouse), *Pecari*, a genus of mammals in the peccary family, Tayassuidae, in addition to *Didelphis marsupialis* and *Myrmecophaga* (Wramc 1998; Lopez 2017).

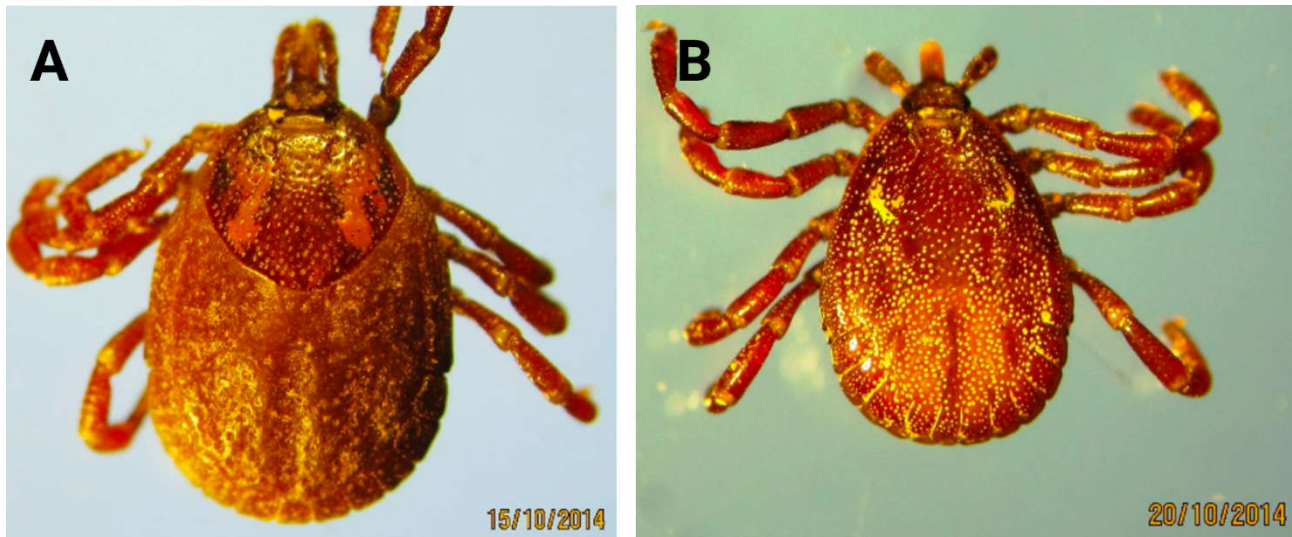
### ***Amblyomma neumanni* Ribaga, 1902**

It has been reported in Argentina, Colombia and Uruguay (Guglielmone *et al.* 2003; Onofrio *et al.* 2006). The primary hosts of *A. neumanni* are domestic and wild ungulates, but dogs and humans are also often parasitized. It has been collected in Colombia from a horse located at “El Nus” Research Center, in the municipality of San Roque, Antioquia, at 840 m of altitude, 23 °C and 2000 mm annual precipitation. Two males and two females were reported in association with *Anocentor nitens* (Lopez Valencia and Parra Danilo 1985). This tick has also been spotted preying on chiguiros (*Hydrochoerus*) (Lopez 2017). New updates, geographic distribution, ecology and pathogenic role in humans are required.

### ***Amblyomma nodosum* Neumann, 1899 (Fig. 4)**

This tick has been reported in Argentina, Bolivia, Brazil, Colombia, Costa Rica, Guatemala, south of Mexico, Nicaragua, Panama, Trinidad and Tobago, and Venezuela (Barros-Battesti *et al.* 2006; Onofrio *et al.* 2006; Voltzit 2007). It commonly infests mammals from the order Xenarthra, such as *Myrmecophaga tetradactyla*, *Tamandua tetradactyla*, and *Tamandua mexicana* (Fairchild 1943; Fairchild *et al.* 1966; Guimarães *et al.* 2001; Martins *et al.* 2004; Bermudez *et al.* 2010; Mazioli *et al.* 2012). *Amblyomma nodosum* is an important vector of *R. bellii* and *R. parkeri* (Ogrzewalska *et al.* 2009). The mature stages parasitize *M. tridactyla* and *T. tetradactyla* (anteater). Birds are the hosts of the immature stages (Barros-Battesti *et al.* 2006). *Amblyomma nodosum* could be misidentified as *A. calcaratum* when both of them are present in the same host due to similarities regarding taxonomic characteristics and morphometrics (Guzmán-Cornejo *et al.* 2006; Onofrio *et al.* 2006). It has been reported in Colombia as both *A. calcaratum* on *T. tetradactyla* and *A. nodosum* on a bird commonly named “toche negro” (*Ramphocelus carbo*) (Wramc 1998). Osorno-Mesa described three females collected from *T. tetradactyla* in Restrepo, Meta (Osorno-Mesa 1942; Rojas-Díaz *et al.* 2012). This species has also been reported parasitizing *Myrmecophaga* spp. (anteaters) and birds *Ramphocelus cardo* (sangre toro) (Lopez 2017). *Amblyomma nodosum* has two pale spots: one in the back corner and an irregular one in a Y shape, on each side. The base of the capitulum is slightly rectangular. A full description of these ticks has been made by Osorno-Mesa and Fairchild and Guzmán (Osorno-Mesa 1942; Fairchild 1943; Guzmán-Cornejo *et al.* 2006). In the Quindío Department, Colombia, an *Amblyomma* sp. – probably *A. nodosum* – collected from *T. tetradactyla* was described (Torres-Mejía and De La Fuente 2006). *Amblyomma nodosum* was recently reported in Valle of Cauca at the Reserva Forestal - Bosque de Yotoco – Universidad Nacional de Colombia 76° 26' 25" W, 3° 50' 48.6" N at 1560 m a.s.l. deposited as 001-5, 001-6 at

CEUNP (Benavides-Montaña *et al.* 2018). Normally, the distribution of these *T. tetradatyla* ranges from sea level to 2000 m a.s.l.; they are found in the eastern Andes of Colombia, Venezuela, Trinidad Island, the Guianas (French Guiana, Guyana, and Surinam), south to northern Uruguay, and northern Argentina, which is consistent with the records currently available. For this tick, new updates, geographic distribution, ecology and pathogenic role in humans are required.



**Figure 4.** *Amblyomma nodosum* – **A.** Dorsal habitus of female; **B.** Dorsal habitus of male. Source: GLV.

#### ***Amblyomma oblongoguttatum* Koch, 1844**

It is distributed in Bolivia, Belize, Brazil, Colombia, Costa Rica, Guatemala, Guyana, French Guiana, south of Mexico, Nicaragua, Panama, Surinam, and Venezuela (Lopez 2017). It infests humans, and domestic and wild animals (Onofrio *et al.* 2006). In Colombia, it has been found parasitizing *Dasyprocta fuliginosa* (agouti) and *Tayassu pecari* (collared peccary) in San Juan de Arama, Meta ( Wramc 1998; Lopez 2017). This species has mostly been reported in Panama, rather than in Colombia, in zopilote *Catharista urubu* (Osorno-Mesa 1942). New updates, geographic distribution, ecology and pathogenic role in humans are required.

#### ***Amblyomma ovale* Koch, 1844**

Reported in Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, French Guiana, Guatemala, Guiana, south of Mexico, Nicaragua, Panama, Paraguay, Peru, Surinam, Trinidad and Tobago, and Venezuela (Onofrio *et al.* 2006). This tick parasitizes different types of hosts during its adult stage, being predominant in carnivorous animals. The immature stages mainly infest Didelphimorphia rodents (Onofrio *et al.* 2006). In Colombia it has been previously reported in dogs by Lopez in the municipality of San Roque (Antioquia) (Lopez Valencia and Parra Danilo 1985). There have been recent reports from Ibaguè and Saldaña, Department of Tolima, from *C. lupus familiaris* (Rivera-Paez *et al.* 2018a). It has recently been described as a vector of *Candidatus R. andeanae* in ticks collected in *C. lupus familiaris* in Ibaguè-Tolima (Rivera-Paez *et al.* 2018b).

#### ***Amblyomma pacaè* Aragão, 1911**

It has been reported in Brazil, Belize, Guyana, Surinam, Colombia, Guiana, Panama, Paraguay, Surinam and Venezuela (Onofrio *et al.* 2006; Voltzit 2007; Lopez 2017). It has been found on

different hosts, mainly rodents (Agoutidae) (Onofrio *et al.* 2006). In Colombia, a female has been reported in guagua or lapa *Agouti paca* in Restrepo-Meta (Osorno-Mesa 1942; Wramc 1998), but it possibly also infests other animals. No recent updates have been reported in Colombia.

### *Amblyomma parvum* Aragão, 1908

It is a Neotropical tick distributed throughout Central America and part of South America, including Argentina, Bolivia, Brazil, Costa Rica, El Salvador, Guatemala, French Guiana, southern Mexico, Nicaragua, Panama, Paraguay and Venezuela (Jones *et al.* 1972; Guglielmone *et al.* 2003; Onofrio *et al.* 2006; Nava *et al.* 2007). This species is found on a wide variety of domestic and wild mammals, and on humans (Onofrio *et al.* 2006). In Colombia, although it has been reported in Los Llanos Orientales on *Dadypus sabanicola* or armadillo (Wramc 1998; Lopez 2017), its role as a potential vector of *Ehrlichia chaffeensis* has not yet been confirmed (Tomassone *et al.* 2008). Nonetheless, the most recent report of *A. parvum* in the Tayrona National Park suggests association with *Rickettsia* spp. (Sierra *et al.* 2017).

### *Amblyomma patinoi* Nava *et al.*, 2014 (Fig. 5)

As we mentioned previously, this tick is part of the *A. cajennense* complex, characterized by six species: *A. mixtum*, *A. patinoi*, *A. cajennense* s.s., *A. interandinum*, *A. tonellidae*, and *A. sculptum* (Rivera-Paez *et al.* 2016). This species was originally described as indigenous from Villeta, Cundinamarca, by Dr. Luis Patiño Camargo in his study regarding identification of rickettsioses in this area (Patino *et al.* 1937). Holotypes, allotypes and paratypes collected by M.B. Labruna, E. Benavides, and G. Valbuena on cattle, vegetation and horses are housed at the National Tick Collection (CNC), at the Faculty of Veterinary Medicine and Zootechnique (FMVZ) of University of Sao Paulo (USP). In Colombia, *A. patinoi* has been collected from cattle, horses, and vegetation (Nava *et al.* 2014); presently it is considered to be distributed along the eastern range of Colombia (Beati *et al.* 2013). The males of *A. mixtum* are very similar to those of *A. patinoi*. It is possible to distinguish them by their particular body outline, which is round in *A. mixtum* and oval in *A. patinoi* whereas females of *A. mixtum* and *A. patinoi* are easily differentiated. However, a clear classification depends on the ticks' preservation (Nava *et al.* 2014). This species is the only known vector of rickettsia that causes the Rocky Mountain spotted fever (R.M.S.F.) in the endemic area of Cundinamarca, Colombia. In this department, Faccini-Martinez *et al.* (2015) were able to isolate *R. rickettsii*, the agent of the deadly R.M.S.F., from the *A. patinoi* tick, in addition to detecting *R. amblyommii*.



**Figure 5.** *Amblyomma patinoi* – A. Dorsal habitus of female; B. Dorsal habitus of male. Source: GLV.

### ***Amblyomma pecarium* Dunn, 1933**

The species is distributed in Colombia, Bolivia, Panama, and South of Mexico. It parasitizes mammals of the order Artiodactyla (Onofrio *et al.* 2006; Lopez 2017). New updates, geographic distribution, ecology and pathogenic role in humans and animals need to be researched.

### ***Amblyomma rotundatum* Koch, 1844**

It has been reported in Argentina, Bolivia, Brazil, Colombia, Costa Rica, Grenada, Guadalupe, Guatemala, French Guiana, Jamaica, Martinique, south of Mexico, Panama, Peru, Surinam, Trinidad and Tobago, and Venezuela (Guglielmone *et al.* 2003; Onofrio *et al.* 2006; Guglielmone *et al.* 2010). This tick reproduces exclusively by parthenogenesis; in some cases, males have been observed (Rodrigues *et al.* 2010). Some of its usual hosts are *Paleosuchus palpebrosus* and *Boa constrictor* (Fiorini *et al.* 2014). Its biological cycle has been thoroughly studied under different laboratory conditions (Luz *et al.* 2013). *Amblyomma rotundatum* has been found on *Rhinella marina* (formerly *B. marinus*). This tick has a huge distribution range from Argentina to Mexico, including the Caribbean Islands (Wramc 1998; Acevedo *et al.* 2016). Recently, *A. rotundatum* was found associated with *R. marina* (Anura: Bofonidae) in Palmira, Valle del Cauca, at 1000 m a.s.l., 76° 18' 00" W, 3° 32' 00" N, deposited in CEUNMP. (003-1, 003-7) (Benavides-Montaño *et al.* 2018). All the ticks collected in this last mentioned study were adult females, which is consistent with the parthenogenesis described in the literature (Barros-Battesti *et al.* 2006). *Rhinella marina* is widely distributed in Colombia and is located from tropical forest to subxerophytic places (0-2100 m a.s.l.) (Ruiz-Carranza and Lynch 1996; Acosta-Galvis 2000). *Rickettsia bellii* has been described from *A. ovale*, *A. rotundatum*, *A. sabanerae*, tick species commonly found feeding on reptiles (Barbieri *et al.* 2012). *Rickettsia belli* as also been reported infecting *A. aureolatum*, *A. dubitatum*, *A. humerale*, *A. incisum*, *A. neumanni*, *A. nodosum*, *A. oblongoguttatum*, *A. ovale*, *A. scalpturatum*, *A. tigrinum*, *H. juxtakochi*, *Ixodes loricatus*, *A. longirostre*. (Labruna *et al.* 2004; McIntosh *et al.* 2015). Though *R. bellii* has been found on dogs and capybaras, the risk of infection for humans is remote (Pacheco *et al.* 2007; Fortes *et al.* 2010).

### ***Amblyomma sabanerae* Stoll, 1894**

This tick has been reported in Belize, Colombia, Costa Rica, El Salvador, Guatemala, South of Mexico, Panama, Honduras, Nicaragua, and Surinam (Onofrio *et al.* 2006; Lopez 2017). Its main hosts are reptiles. It has been recently disclosed on a new host: river turtles, *Rhinoclemmys* (*R. nasuta* and *R. melanosterna*) (Garcés-Restrepo *et al.* 2013b). Schulze (1937) described the presence of *A. sabanerae* in Colombia; unfortunately, the host and locality were not specified (Osorno-Mesa 1942). It has been reported in Antioquia and Choco on *Rhinoclemmys annulata* and *B. constrictor* (Lopez 2017), in Valle del Cauca, on the Pacific coastal plain: Playa Chucheros (3.93228° N, 77.30784° W), San Pedro (3.83337° N, 77.24925° W), San Isidro (3.44972° N, 77.16487° W) as well as on a continental island known as Isla Palma (3.90019° N, 77.35597° W), where samples of *A. sabanerae* were collected and deposited in the Teaching Collection (CD) of the Zoology Department of the Universidad del Valle (Cali) (Garcés-Restrepo *et al.* 2013a). This tick has been associated with the presence of *R. bellii* in the Neotropical region (Barbieri *et al.* 2012; Parola *et al.* 2013). Ernst and Ernst (1977) recorded four species of the genus *Amblyomma*: *A. cajennense*, *A. dissimile*, *A. rotundatum*, and *A. sabanerae* associated with *Rhinoclemmys* species in the Neotropics. Specimens of the most commonly identified tick species, *A. sabanerae*, were collected from five species of *Rhinoclemmys*, including two species of *R. annulata* from Colombia (Ernst and Ernst 1977).

### *Amblyomma scalpturatum* Neumann, 1906

Its occurrence was confirmed in the Amazon area of Venezuela, Guyana, Peru, Ecuador, Bolivia, Surinam, and Brazil. There are other records from Colombia and French Guiana (Voltzit 2007). The South American tapir (*Tapirus terrestris*) is the primary host of this tick during its adult stage (Labruna *et al.* 2005; Onofrio *et al.* 2006). A recent review of the taxonomic status of *A. incisum*, *A. scalpturatum*, and *A. latepunctatum* provided us with updated host and geographical distribution data for *A. scalpturatum* (Labruna *et al.* 2005). The most common hosts are Perissodactyla and tiasuideos (Onofrio *et al.* 2006). In Colombia, the species has been reported on monkeys (San Juan de Arama, Meta) and tapirs (Lopez 2017).

### *Amblyomma tigrinum* Koch, 1844 (Fig. 6)

It has been identified in countries such as Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, French Guiana, Paraguay, Peru, Uruguay, and Venezuela, parasitizing carnivorous in its adult stage (Onofrio *et al.* 2006; Lopez 2017). Typically, larvae and nymphs are found on birds (Onofrio *et al.* 2006). Nava *et al.* (2006) discovered that the most important natural hosts for larvae of *A. tigrinum* are small rodents (Cricetidae: Sigmodontinae) and ground feeding birds, whereas the principal host for nymphs is the rodent *Galea musteloides* (Caviidae: Caviinae) (Nava *et al.* 2006, 2009). This tick has been reported as a vector of *R. parkeri*, an emerging tick-borne disease (Lado *et al.* 2014). In Colombia its presence has been described on *Agouti paca*, cattle, and birds such as Zanate Caribeño, which is also known as Tordo Negro or Tordo Llanero (*Quiscalus lugubris*) (Lopez 2017).



**Figure 6.** *Amblyomma tigrinum* – A. Dorsal habitus of female; B. Dorsal habitus of male. Source: GLV.

### *Amblyomma triste* Koch, 1844

The occurrence of *A. triste* is confirmed for Argentina, Brazil, Colombia, Ecuador, Peru and Uruguay and Venezuela (Onofrio *et al.* 2006). Adults of *A. triste* feed primarily on carnivores, but they have also been collected from humans (Venzal *et al.* 2003; Guglielmone *et al.* 2006). The immatures stages have been collected from rodents and Didelphimorphia. As for *A. tigrinum* and *A. maculatum*, often mistaken for *A. triste*, the delimitation of its areas of distribution is uncertain

(Onofrio *et al.* 2006) (Kohls 1956; Aragão and Fonseca 1961). The mature stages parasite carnivorous animals and it is considered one of the most common ticks on deer. In Colombia, this species has been reported in Carimagua, Llanos Orientales, associated with dogs (*C. l. familiaris*) (Lopez 2017) and deer (Wramc 1998). There is no current available research for this species.

### ***Amblyomma tapirellum* Dunn, 1933**

Originally described from Panama, this mite has also been collected in Nicaragua, Colombia, Belize, and Venezuela (Dunn 1933; Guglielmone *et al.* 2003; Onofrio *et al.* 2006; Voltzit 2007; Lopez 2017). Tapir (*Tapirus bairdii*) is the main host for this tick; however, this species has also been collected from domestic and wild animals such as *Odocoileus virginianus* and *Pecari tajacu*. Recently, a new ecological relation between *A. tapirellum* and arboreal mammals such as monkeys has been proposed (Loaiza *et al.* 2013). In Colombia, reports associate this tick with "Puerco de monte" peccary and *Alouatta palliata* (howler monkey) (Wramc 1998).

### ***Amblyomma varium* Koch, 1844**

It is reported from Argentina, Brazil, Chile, Colombia, Costa Rica, French Guiana, Guatemala, Nicaragua, Panama, Peru, and Venezuela; (Jones *et al.* 1972; Guglielmone *et al.* 2003; Barros-Battesti *et al.* 2006; Onofrio *et al.* 2006). Xenarthra (anteater), armadillos and sloths are the main hosts. This tick has been reported in Colombia on sloths, *Bradypus griseus* (Lopez 2017), in *Bradypus tridactylus* in Condoto – Choco, and in Panama, where it is commonly found parasitizing *Choloepus hoffmanni* (Osorno-Mesa 1942; Wramc 1998; Voltzit 2007). Recently, a new update has mentioned its presence on *C. l. familiaris* from Ibaguè, Tolima (Rivera-Paez *et al.* 2018a). Except for these few reports in Colombia, nothing is known about the biology and ecology of this tick species, hence the need for research that describes it thoroughly; it is likely that the specimens reported by Rivera on a pet dog were an accidental parasitism since this species feeds mostly on sloths (Marques *et al.* 2002).

### ***Haemaphysalis juxtakochi* Cooley, 1946**

This tick was first reported in Venezuela under the name of *H. kochi* by Vogelsang and Cordero (1940). These researchers identified it as a parasite of Brocket deer (*Mazama rufa*), paca (*Coelogenys paca*) and *Odocoileus* sp. Cooley (1946) recovered it from a tapir at Selva, Gran Sabana, Venezuela. This tick is distributed from Mexico to Argentina (Panama, Brazil, Colombia, Uruguay, and Trinidad) (Martins *et al.* 2007). It is widely distributed in countries such as Panama (García *et al.* 2014). The Rocky Mountain Laboratories collection (RML collection) contains specimens from Bolivia and Surinam. Preferred hosts for adults of *H. juxtakochi* appear to be species of deer, although it is also found on rodents, perissodactyls, and rarely on lagomorphs and primates. This tick undergoes a three-host cycle in which deer are likely to be their main primary host. *H. juxtakochi* has been reported on several mammalian species, including alpacas, *Lama pacos*, rodents, lagomorphs, cattle, dogs, armadillos, tapir, non-human primates and also on birds (Jones *et al.* 1972; Beldomenico *et al.* 2003; Guglielmone *et al.* 2004; Suárez *et al.* 2005; Martins *et al.* 2007). The presence of a *Rickettsia rhipicephali* and *R. bellii* in *H. juxtakochi* has already been reported (Labruna *et al.* 2005, 2007).

### ***Haemaphysalis leporispalustris* (Packard, 1869) (Fig. 7)**

This tick has been detected in the Americas on wild rabbits and birds (Zeringota *et al.* 2016). The presence of this tick may be associated with the existence of different etiological agents such as

*Rickettsia rickettsii*, *R. parkeri*, *R. bellii* and *R. canadensis*, *Borrelia burgdorferi*, *Babesia* sp., *Anaplasma bovis* and *Anaplasma phagocytophilum*, *Coxiella burnetii*, *Francisella tularensis* (Zeringota *et al.* 2016). It has been reported in Colombia on domestic and wild rabbits as well as in Central American Agouti (*Dasyprocta punctata*) in Muzo, Department of Boyaca; some nymphs have been reported on humans from Girardot, Cundinamarca (Osorno-Mesa 1942). *Haemaphysalis leporis proxima* (Aragao 1911) reported by Osorno-Mesa (1942) as a variety of *H. leporis palustris*, is a synonym rather than a new species collected from wild animals and domestic rabbits from Panama (Guglielmone *et al.* 2006).

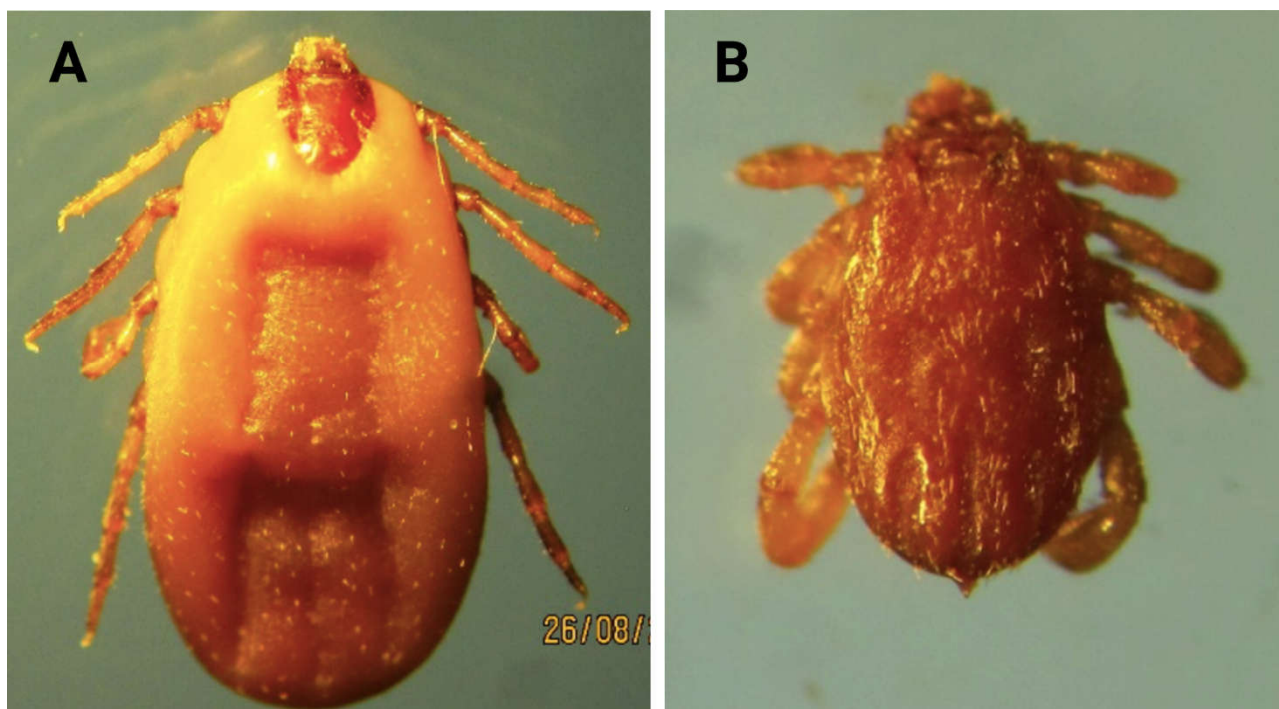


**Figure 7.** *Haemaphysalis leporis palustris* – A. Dorsal habitus of female; B. Dorsal habitus of male. Source: GLV.

### ***Rhipicephalus (Boophilus) microplus* (Canestrini, 1887) (Fig. 8)**

*Rhipicephalus (Boophilus) microplus* is one of the most important ticks on domestic animals associated with different environmental conditions. The main host in South America and Colombia is cattle (Todorovic *et al.* 1973; Luque 1975; López 1980; Estrada-Peña *et al.* 2006), but it is possible to find it on other hosts such as horses and dogs. In other countries *R. (B.) microplus* has also been found on *Blastocerus dichotomus*, *Mazama gouzaubira*, and *Ozotoceros bezoarticus* (Bechara *et al.* 2000). *Rhipicephalus (B.) microplus* causes considerable economic losses to producers by blood sucking, disease transmission and costs of control. The economic loss worldwide has been estimated in US \$ 7 billion/year (De Castro 1997). In Colombia, the losses could be close to US \$146 million/year, considering a population of 20 million cattle exposed to ticks, and an annual cost head/year of US \$7.3 (García 1983; Lopez 2017; López and Parra 2017). These estimates do not take into account the considerable economic loss associated with the use of acaricides employed in controlling the plague. Unfortunately, the abuse of acaricides has favored resistance to different acaricides (Nasayo *et al.* 1997; Álvarez and Bonilla 2007; Rodríguez *et al.* 2012). In Colombia, *Rhipicephalus (Boophilus) microplus* seems to be becoming adapted to high altitudes (more than 2600 m a.s.l.), where it had not been frequently reported before (Cortés *et al.* 2010). *Rhipicephalus (Boophilus) microplus* has the ability to survive under anthropogenic modifications of land surface, agrarian practices, and the adaptation of forest areas into pastureland for cattle, which also transform the natural function of the ecosystems. *Rhipicephalus (Boophilus) microplus* is able to survive in different ecological areas, and extreme environmental and human conditions. This tick might represent a helpful biomarker or indicator of threats to biodiversity as a consequence of human impact in strict associations with protected or conservation areas; locations which receive protection because of their recognized ecological nature. In Colombia its presence

has been reported between 0–2900 m a.s.l. (Cortés *et al.* 2010; Lopez 2017) which is unusual and probably associated with climate change. Nowadays, its presence in Colombian territory is endemic, confirmed in multiple regions such as Amazonas, Antioquia, Arauca, Bolivar, Caldas, Casanare, Cundinamarca, Meta, Tolima, Valle del Cauca, Nariño (López 1980; Arias *et al.* 1991; Betancourt *et al.* 1992; Cortés *et al.* 2010; Rivera-Paez *et al.* 2018b). It is the most important vector of the rickettsia *Anaplasma marginale* and the protozoa *Babesia bigemina* and *Babesia bovis* (Benavides *et al.* 2016; Lopez and Vizcaino 1992).



**Figure 8.** *Rhipicephalus (B.) microplus* – A. Dorsal habitus of female; B. Dorsal habitus of male. Source: GLV.

***Rhipicephalus sanguineus* complex**  
***R. sanguineus sensu stricto* (s.s.) (Fig. 9)**

It is part of the *Rhipicephalus sanguineus* complex, represented by 17 species in the world (Sanchez *et al.* 2016). This species was firstly classified as *Ixodes sanguineus* Latreille, 1806 and later transferred to the genus *Rhipicephalus* family by Koch (1844). This species is composed of two strains, morphologically and genetically distinct in the Neotropics: a southern (temperate) strain, located in Argentina, Uruguay, Chile and south Brazil; and a northern lineage (located in tropical and subtropical regions) in Brazil, Paraguay, Colombia, South Africa, Mozambique, and northern Argentina (Moraes-Filho *et al.* 2011). In Colombia, there have been reports regarding the presence of the northern lineage, with samples from La Libertad, Magdalena, provided by Dr. Efrain Benavides Ortiz (University of La Salle, Bogotá, Colombia). However, this species probably belongs to a lineage different from *R. sanguineus* (Sanchez *et al.* 2016). New studies need to focus on morphological, genetic and biological aspects of this tick in different geographical regions (Moraes-Filho *et al.* 2011). *Rhipicephalus sanguineus* s.s. is probably the most widespread tick around the world. Its main hosts are rural and urban *C. l. familiaris*, but it also feeds on wild animals in captivity or free-living ones, such as rabbits, cats, Norway rat, pigeons, and wild canids (Dantas-Torres 2008). This tick transmits different hemoparasites of zoonotic concern, such as *Coxiella burnetti*, *Ehrlichia canis*, *Rickettsia conorii* and *R. rickettsii*, *R. massiliae*, *Anaplasma platys*, *Babesia canis vogeli*, *B. gibsoni* and *Leishmania infantum*, among others. (Dantas-Torres

2008; Otranto *et al.* 2009; Labruna *et al.* 2011; Dantas-Torres *et al.* 2012). The ecology and biology of this species have been previously described, but it is important to restate this tick's outstanding capacity to adapt and live in humid environments and resist desiccation (Koch and Tuck 1986). In some cases, high temperatures help this tick to attach more rapidly to rabbits and humans (Parola *et al.* 2008). Climatic conditions and availability of hosts are the major factors that determine its survival (Parola and Raoult 2001; Suss *et al.* 2008). *Rhipicephalus sanguineus* and *A. cajennense* have been associated with the presence of *R. rickettsii* in Villeta and Tobia, Cundinamarca, Colombia (Hidalgo *et al.* 2007). In domestic herds, *C. l. familiaris* are often involved in human labor activities, which explain the presence of this tick in cattle farms. In Colombia, the ticks of the *R. sanguineus* group are present from rural areas in the Caribbean coast to highly urbanized locations in the Andean zone at 2600 m a.s.l. (Acero EJ 2011; Paternina *et al.* 2009). In Colombia, a prevalence of 92.1% in *C. familiaris* has been reported (Paternina *et al.* 2009). This tick is endemic in Valle del Cauca, where it is usually associated with *C. l. familiaris*. It is deposited in the CEUNP tick collection (Benavides-Montaño *et al.* 2018), and it is considered the main vector of *E. canis* and *B. canis vogeli* due to its high capacity to adapt to urban environments (Benavides-Montaño and Ramírez 2003; Vargas-Hernandez *et al.* 2012; Rojas-Triviño *et al.* 2013). This tick was recently reported as a vector of *Candidatus Rickettsia andeanae* from ticks collected in *C. l. familiaris* in Leticia-Amazonas (Rivera-Paez *et al.* 2018b) and other rickettsiales such as *Ehrlichia canis*, *Anaplasma platys*, *Rickettsia felis* (Paternina *et al.* 2017), *Babesia canis vogeli* and *Hepatozoon canis* (Guevara-Vega *et al.* 2017).



**Figure 9.** *Rhipicephalus sanguineus* – A. Dorsal habitus of female; B. Dorsal habitus of male. Source: GLV.

### ***Dermacentor (Anocentor) nitens* Neumann, 1897 (Fig. 10)**

The genus *Dermacentor* is represented by 35 species around the world (Lopez 2017). The species of this genus transmit different pathogens such as *Rickettsia* spp., *Coxiella* spp., *Anaplasma* spp., *Francisella* spp. and *Babesia* spp. (Lopez 2017). There are eight species in the Neotropical region; four of them are exclusive to the Neotropic: *D. imitans*, *D. nitens*, (trioxenos), *D. albipictus* and *D. nitens* (monoxenos) (Barros-Battesti *et al.* 2006). In Colombia, *Dermacentor nitens* is endemic and it has been reported in different localities of Cundinamarca, Meta, Boyacá, Antioquia, and Atlántico; such as Villeta (Cundinamarca), Restrepo and Villavicencio (Meta) on horses, Muzo, Mani, Trinidad (Boyacá) on humans, Medellín (Antioquia) on horses, Barranquilla (Atlántico) on donkeys (Osorno-Mesa 1942; Wramc 1998). A female of *D. imitans* (RML 668550) in 1967 was

found in Curiche Choco associated with humans and *Tayassu pecari* (Wramc 1998; Guglielmone *et al.* 2006). *Dermacentor nitens* has been reported for tropical and subtropical regions in north, center and south America, including The Caribbean and Galapagos islands (Yunker *et al.* 1986). The spirochete *Borrelia burgdorferi* has been detected in *D. nitens* collected from traction horses (Gonçalves *et al.* 2014). *Dermacentor nitens* is a natural vector of *Babesia caballi*, one of the etiological agents of equine piroplasmosis in the Americas (Schwint *et al.* 2008). *Dermacentor nitens* “common horse tick” has been found on cattle (Reyes 1948), in association with the presence of babesiosis, theileriosis and anaplasmosis (Luna 1958) in Monteria (Cordoba), Bugalagrande (Valle del Cauca) and Sumapaz (Maurer 1969; Todorovic *et al.* 1970; Wells 1975; Tenter *et al.* 1988). In Córdoba, Tenter *et al.* (1988) found *D. nitens* in all the 13 farms they surveyed and *A. cajennense* in two of them. In their study, the serological prevalence using immunofluorescence was > 90% for *B. caballi* and *T. equi* and using the complement fixation (FC) test a prevalence of 41% for *B. caballi* and 65% to *Theileria. equi* (Tenter *et al.* 1988). Under usual circumstances, *D. nitens* is found on animals infected with babesiosis in Valle del Cauca, in association with *A. cajennense* and *A. maculata*. However, *Dermacentor nitens* is more predominant than *A. cajennense* (Benavides-Montaño *et al.* 2018). Horses that have to travel long distances are more prone to this tick (Barros-Battesti *et al.* 2006; Álvarez and Bonilla 2007). This tick was described as a vector of *A. platys* and *Rickettsia* spp. *Rickettsiae* have been found in *D. nitens* collected from horses in the Tayrona National Natural Park (Sierra *et al.* 2017). Ramirez (2014), employing molecular techniques (gen gltA), showed the existence of *R. rickettsii* and *R. felis* in *D. nitens* from samples collected in Villeta, Cundinamarca (Ramírez 2014). *Dermacentor nitens* has been reported associated with *A. maculatum* from *E. caballus* and *Mular assinus* in Dagua –Valle del Cauca, and also collected from *Bos taurus* and *B. indicus* in different regions of Valle del Cauca, including Yotoco/Cordobita (Benavides-Montaño *et al.* 2018). This domestic and wild tick poses a risk to human population due to its capacity to transmit hemoparasites and disease agents such as parvovirus, *E. canis*, *B. vogeli*, *B. canis*, *A. phagocytophilum*, *A. platys*, *Toxoplasma gondii* and *Leishmania infantum* (Baneth 2014).



**Figure 10.** *Dermacentor (Anocentor) nitens* – **A.** Dorsal habitus of female; **B.** Dorsal habitus of male. Source: GLV.

### ***Dermacentor imitans* Warburton, 1933**

It is distributed from the south of Mexico, Guatemala, Costa Rica, Panama, and Venezuela (Lopez 2017). In Colombia, it has been found parasitizing humans and Zainos *Tayassu tajacu*

(Artyodactyla) in the Baudo river area (Lopez 2017). A female was recovered in the locality of Curiche - Choco Colombia in 1967, accession number (RML39142) (Wramc 1998; Guglielmo *et al.* 2006). Although this tick has not been officially reported in Colombia, we included it as part of this review. Future studies need to collect and research more holotypes.

### **The genus *Ixodes* Latreille, 1795**

The genus *Ixodes* comprises about 240 species of ticks around the world; 46 of them are reported in the tropical region and 14 in Colombia (Osorno-Mesa 1942). In South America, there are only two ticks as part of the complex *Ixodes ricinus*, which correspond to *Ixodes affinis* and *Ixodes pararicinus* (Venzal *et al.* 2005; Benavides *et al.* 2017b). Some authors report the presence of *I. pararicinus*, but not *I. affinis* (Rivera-Paez *et al.* 2018a); others such as Gustavo Lopez and E. Benavides noted the presence of both *I. pararicinus* and *I. affinis*. In this review, none of the two species are excluded, and more than 10 species of *Ixodes* genus previously reported in Colombia by Rivera-Paez are mentioned, including: *Ixodes tapirus*, *I. auritulus*, *I. andinus*, *I. bocatorensis*, *I. tropicalis*, *I. boliviensis*, *I. brunneus*, *I. fuscipes*, *I. lasallei*, *I. luciae*, *I. montoyanus*, *I. pararicinus*, *I. tapirus*, *I. tropicalis*, and *I. venezuelensis*. Fifteen additional *Ixodes* spp. have been reported in Colombia, but they need to be validated and updated.

### ***Ixodes auritulus* Neumann, 1904**

This tick is distributed in Australian, Ethiopian, Nearctic and Neotropical zoogeographic regions, with a variable and discontinuous distribution in countries such as Guatemala, Costa Rica, Venezuela, Colombia, Ecuador, Peru, Chile, Brazil, Argentina and Uruguay (Barros-Battesti *et al.* 2006; Bermudez *et al.* 2015b). Normally, it infests *Seiurus aurocapillus* birds (Parulidae), *Catharus gracilirostris*, *Turdus nigrescens*, *T. plebejus* (Turdidae), *Thryorchilus browni* (Troglodytidae), *Junco vulcani* (Emberizidae) and *Oreophasis derbianus* (Cracidae). All the stages have been described in the MNHN (Barros-Battesti *et al.* 2006; Bermudez *et al.* 2015a). This tick inhabits regions with low temperatures, such as highlands in equatorial mountains (Bermudez *et al.* 2015b).

### ***Ixodes affinis* Neumann, 1899**

The presence of *Ixodes affinis* has been reported in Belize, Brazil, Costa Rica, Colombia, Ecuador, Guatemala, Panama, Peru, Uruguay, and south of México in rodents, deer and ocelots (Barros-Battesti *et al.* 2006; Benavides *et al.* 2017b; López and Parra 2017). Future studies are required in order to validate its presence or categorize the sporadic events in Colombia as well as to strengthen the collections.

### ***Ixodes andinus* Kohls, 1956**

It is present in Peru, infesting mammals of the order Rodentia. Female, nymph, and larval stages have been described. Type: CNHM, United States National Tick Collection (USNTC) (Barros-Battesti *et al.* 2006). In Colombia, it is believed to parasitize *Oryzomys albigularis* (rice rat) (Wramac 1998), but this claim has not been confirmed.

### ***Ixodes bocatorensis* Apanaskevich & Bermudez, 2017**

The name of this tick is derived from Bocas del Toro, a province of Panama where the holotype, allotype, and paratypes were collected for the first time (Apanaskevich *et al.* 2017). Adults of this tick were collected from agoutis (Rodentia: Dasyproctidae), pacas (Rodentia:

Cuniculidae), tapirs and sloths (Perissodactyla: Tapiridae and Pilosa) in Colombia (Antioquia Department), Panama, (Bocas del Toro and Los Santos Provinces) and Venezuela (Bolivar, Carabobo, and Falcon States); samples lay in the USNTC. These ticks were previously classified as *Ixodes lassallei* by Kohls and Clifford (1966) and actually represent this new species as a product of the re-examination of this collection (Apanaskevich *et al.* 2017).

#### ***Ixodes boliviensis* Neumann, 1904**

Originally categorized from a male, female and nymph collected from a bush dog *Speothus venaticus* in Bolivia (Neumann 1904). Subsequently, this tick has been reported parasitizing several species of mammals, especially carnivora, in locations ranging from southern Mexico to Bolivia and Peru (Guglielmone 2004; Onofrio *et al.* 2006; Troyo *et al.* 2014). It also parasites birds, deer, squirrels, horses and humans (Guzmán-Cornejo and Robbins 2010). This species is commonly found in mountainous areas, at altitudes varying from 800 to 2500 m a.s.l. (Bermudez *et al.* 2015a). In Colombia, this species was collected from *D. marsupialis* in Muzo, Boyacá department, by J. Boshell M (Osorno-Mesa 1942) and from *C. l. familiaris* (Lopez 2017).

#### ***Ixodes brunneus* Koch, 1844**

This tick is present in the Nearctic, where it parasitizes a variety of bird families, including migratory species (Fairchild *et al.* 1966). It is distributed in Argentina, Colombia, Panama (Barros-Battesti *et al.* 2006). In Colombia, Osorno-Mesa described a female collected from a bird *Ramphocelus coccineus* from Bogota and two arboreal toucans (Osorno-Mesa 1942). The species is considered to be restricted to the Andean Paramo (Mantilla *et al.* 2011). In spite of recent reports, its presence in Colombia has not been confirmed yet (Osorno-Mesa 1942; Bermudez *et al.* 2015b; Rivera-Paez *et al.* 2018a). The bird species 'cinclodes' is a passerine bird, belonging to the ovenbird family Furnariidae. It has been described in Venezuela, but it still is not completely established in the Neotropic area. All these birds are Neotropical resident birds, but not Nearctic birds. This fact makes it impossible to infer habitat preferences. Because the samples were not examined during this revision, additional studies are necessary to determine if they truly correspond to *I. brunneus* or belong to an undescribed species. New updates, geographic distribution, ecology and pathogenic role in animals and humans are required.

#### ***Ixodes fuscipes* Koch, 1844**

It is present in Brazil, Colombia, and Peru. The description of this species in Panama was questioned; in fact, it is not included in the area of distribution (Keirans and Ajohda 2003). This tick parasitizes mammals of the order Rodentia, mainly *Agouti paca*, the genus *Dasyprocta* (*D. variegatus*) with female and immature stages; males of *I. fuscipes* are not researched (Barros-Battesti *et al.* 2006; Martins *et al.* 2014).

#### ***Ixodes lasallei* (Mendez Arocha & Ortiz 1958)**

It is present in Peru, Panama, Venezuela, and Colombia, parasitizing mammals of the order Rodentia. Male and females of this tick have been described in the literature (Barros-Battesti *et al.* 2006). In Colombia, it has been reported by Gustavo Lopez parasitizing agouti, *Dasyprocta aguti* (López and Parra 2017). Adults of this species are similar to *Ixodes bocatorensis*, but they can be distinguished by the scutum dimensions, punctuation pattern, gnathosoma, palpi measurements ratios, basis capituli anterior angle and shape of the spur of the palpal segment I ventrally. The male of *I. lasallei* was described for the first time from adults found on agoutis, pacas, and Ocelots

(Apanaskevich *et al.* 2017). The *agouti paca* is distributed from sea level until 1600 m a.s.l. (Mondolfi 1972); it inhabits the entire Colombian territory (Morales *et al.* 2004); it is also distributed from Mexico to north of Argentina as well as Cuba, Lesser Antilles, Guyanas and Brazil (center and south).

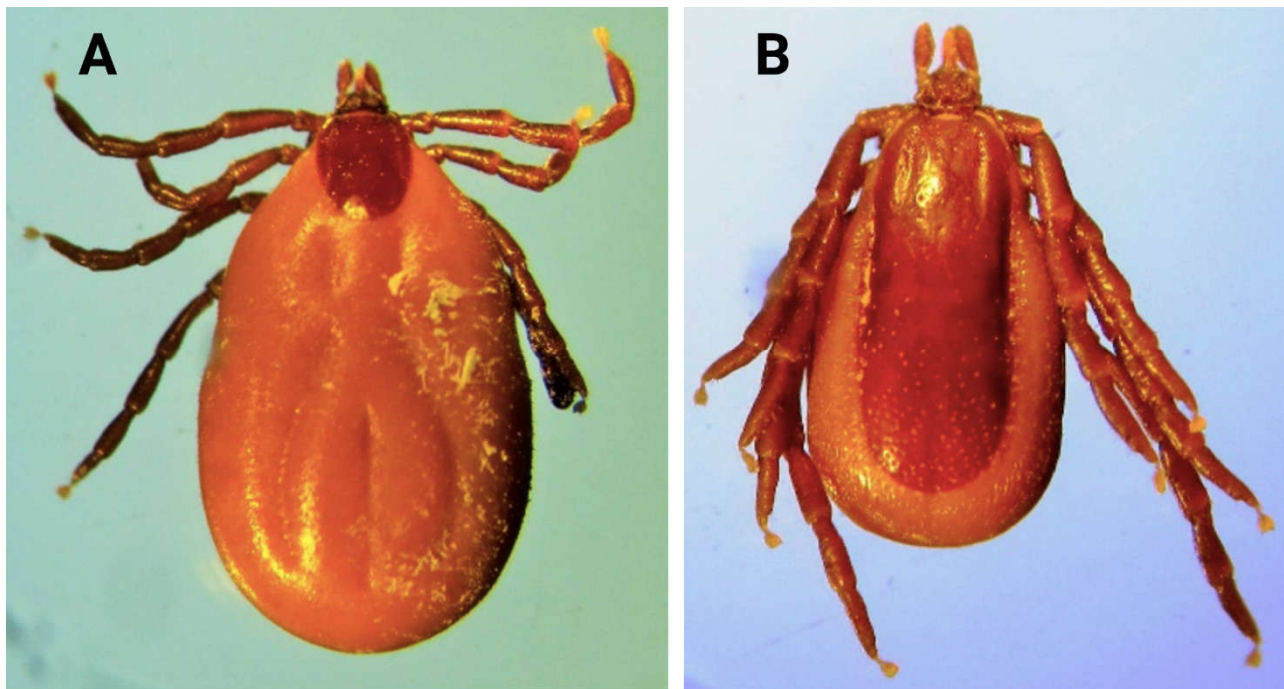
### ***Ixodes loricatus* Neumann, 1899**

Syn.: *I. coxaefercatus* and *I. didelphidis* (Marques *et al.* 2004).

This tick is present in Argentina, Brazil, Guatemala, south of Mexico, Paraguay, Uruguay, Venezuela and Colombia (Osorno-Mesa 1942; Barros-Battesti *et al.* 2006). The immature phases are rodent parasites, whereas the adult phase feeds on marsupials. All the stages have been described as type: BMNH, ENV (Barros-Battesti *et al.* 2006). This tick is commonly named “the black-legged tick”. It is a three-host tick and normally it is propagated from Mexico to Argentina (Colombo *et al.* 2014) parasitizing Didephidae marsupials, but rodents of the subfamily Sigmodontinae (rats and mice) are considered important to sustain larvae and nymph stages (Colombo *et al.* 2014). This species in Colombia was described by Dr. Bequaert collected from chucha real, *Metachirus longicaudatus columbianus*, collected in Restrepo, Meta, by Dr. J Boshell M. Other samples were collected from *Didelphis marsupialis* from Muzo (Boyacá) and Villavicencio (Meta) (Lopez 2017; Osorno-Mesa 1942).

### ***Ixodes luciae* Sénevet, 1940 (Fig. 11)**

It is a Neotropical tick widely distributed in South America: Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, French Guiana, Guatemala, Honduras, Mexico, Nicaragua, Panama, Peru, Surinam, Trinidad and Tobago, and Venezuela (Guglielmone *et al.* 2003; Barros-Battesti *et al.* 2006). The immature stages parasitize rodents whereas the adults feed on marsupials; both males and females have been described (Barros-Battesti *et al.* 2006). Some studies reported the presence of *I. luciae* nymphs restricted to *Hylaeamys perenensis*, *Hylaeamys yunganus*, *Oligoryzomys microtis* and *Oecomys bicolor* infested with larvae of this species. The diagnosis of the larva of *I. luciae* was developed through the analysis of the taxonomical keys of Onofrio *et al.* (2009), differentiating *Ixodes loricatus* from other Ixodidae whose adults are common on *D. marsupialis* (Nava *et al.* 2004). According to previous reports in Colombia, *Ixodes loricatus* and *I. luciae* are morphologically closely-related and have several ecological similarities in the loricatus group (Barros-Battesti *et al.* 2006). In Colombia, *Ixodes luciae* has been reported associated with *D. punctata* (guatín) and *D. marsupialis* (common opossum) (Wramc 1998; Lopez 2017). *Ixodes loricatus* and *Ixodes boliviensis* have been found on *D. marsupialis*. A nymph of *Ixodes boliviensis* collected in Muzo (Boyacá department) was reported as *I. loricatus*. It was collected from chucha real (*Metachirus longicaudatus* from Restrepo, Meta, by Dr. J. Boshell M and other samples from *D. marsupialis* from Muzo, Boyaca Department, and Villavicencio, Meta (Osorno-Mesa 1942). *Ixodes luciae* has also been associated with *Metachirus nudicaudatus* (opossum), *Oryzomys gorgasi* (rice rat) and *Oryzomys capito* (Wramc 1998). *Oryzomys gorgasi* was collected by the U.S. Army Medical Department between 1950–1967 in the Antioquia Department at northwestern Colombia and in the interoceanic canal routes in Panama and Colombia. The complex *Ixodes ricinus* are vectors of *Borrelia burgdorferi*, but only *I. affinis*, *I. aragaoi*, *I. minor* and *I. pararicinus* are in the Neotropic (Barros-Battesti *et al.* 2006). Regarding *I. luciae*, although some reports affirm that this species could parasitize humans, there is no information regarding human or animal diseases transmitted by this tick (Díaz *et al.* 2009). No updates have been made recently for this tick in Colombia.



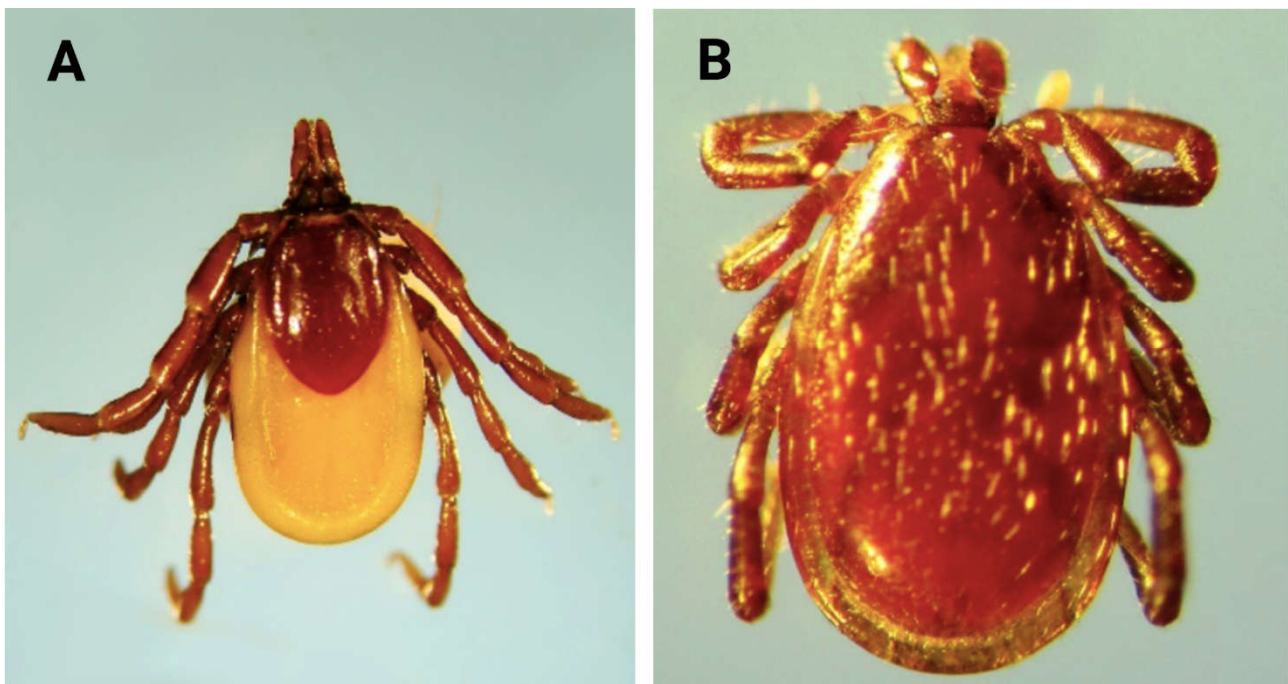
**Figure 11.** *Ixodes luciae* – A. Dorsal habitus of female; B. Dorsal habitus of male. Source: GLV.

#### ***Ixodes montoyanus* Cooley, 1944**

It has been identified in Colombia and Venezuela, feeding on mammals of the order Artiodactyla. All the stages are described in USNTC, USNM, MCZ, FCM (Barros-Battesti *et al.* 2006). In Colombia, five *Ixodes* females collected from *Nasuella olivacea* (cusumbos) in Monserrate hill (Bogotá) were reported by Dr. Juan A. Montoya in the Oficina Sanitaria Panamericana Washington, D.C. There are descriptions of immature stages with records from Colombia and Venezuela (Cooley 1944; Keirans 1973; Lopez 2017). The species lays in the Rocky Mountain (Hamilton, Montana), the National Museum of United States, (Washington, D.C), and in the Museum of Zoology, University of Harvard (Cambridge, Massachusetts) (Cooley 1944).

#### ***Ixodes pararicinus* Keirans & Clifford, 1985 (Fig. 12)**

It is distributed in Argentina, Colombia, Uruguay and probably in Peru. The adult stage parasites mammals of the order Artiodactyla, whereas immature stages feed on birds and rodents. All the stages are already described as the type species: USNTC, Museo Argentino de Ciencias Naturales 'Bernardino Rivadavia (MCN), BMNH, INTA (Barros-Battesti *et al.* 2006). This tick has been classified in Colombia as *Ixodes ricinus* in Cattle and horses (Lopez 2017; Reyes 1948); however, they actually are *I. pararicinus* (Guglielmone *et al.* 1992). This species has not been reported in the literature infecting humans and most of the records come from domestic animals such as cattle, horses, sheep, and goats (Venzal *et al.* 2005). In Colombia, it has been reported in cattle, horses, *C. lupus familiaris* and humans in Carmen de Atrato and San José del Palmar (Chocó) (Lopez 2017). Although this *Ixodes* has been reported as a carrier of the Lyme disease causal agent, the spirochaete *B. burgdorferi* s. l. (Venzal *et al.* 2005), *I. pararicinus*, in Colombia it has not been described harboring *B. burgdorferi* (Mattar and Lopez Valencia 1998). Nevertheless, it is not possible to discard its role as a vector of this disease (Lopez 2017). New records in foothills of the eastern cordillera between Antioquia and Chocó confirm its presence (Benavides *et al.* 2017b).



**Figure 12.** *Ixodes pararicinus* – A. Dorsal habitus of female; B. Dorsal habitus of male. Source: GLV.

### *Ixodes tapirus* Kohls, 1956

This tick has been reported in Colombia and Panama. It parasitizes mammals of the order Perissodactyla. The female is described Type: CNHM (Barros-Battesti *et al.* 2006). It was described from a single female collected on mountain tapir, *Tapirus pinchaque* (Roulin, 1829) (Perissodactyla: Tapiridae) in the Colombian Andes (Kohls 1956). Later, Fairchild *et al.* (1966) reported two collections totaling six females found on Baird's tapir, *Tapirus bairdii* (Gill, 1865) in two highland localities of western Panama (Fairchild *et al.* 1966). The male and the immature stages were not analyzed. Recently it was compared with a female holotype from *T. pinchaque*, Rio Majuas (1570 N, 76240 W), 2700 m a.s.l., San Agustín, Huila, Colombia, 21.x.1951, P. Hershkovitz; deposited in the FMNH (FMNHINS 3474346). This female of *I. tapirus* collected in Colombia is slightly different from the studied specimens from Costa Rica and Panama. For instance, they were found to have smaller and sparser punctations along the posterior margin of the scutum and a reduced 4th row of denticles on the hypostome (there is only 1 denticle in the 4th row on one of the sides). However, based on other qualitative and quantitative characters, it is similar to the other available specimens. Described variables can be attributed to geographic or individual variability. *Ixodes tapirus* is confined to highlands of Colombia (Huila Department), Panama (Chiriquí Province) and for the first time, it was recorded in Costa Rica (San José Province). All collections were made at elevations exceeding 2000 (2012–3353) m a.s.l. Males and females of this species were collected from vegetation, and females were also collected from two species of tapirs, *T. pinchaque* and *T. bairdii* (Apanaskevich *et al.* 2017).

### *Ixodes tropicalis* Kohls, 1956

This species is present in Colombia and Peru, where it parasitizes mammals of the Rodentia order. Only the female is described as type: CNHM, USNTC (Barros-Battesti *et al.* 2006; Rivera-Paez *et al.* 2018a). It has been reported in montane moist broadleaf forests of Valle del Cauca on

*Cricetidae echimyidae*. The larvae and nymph stages have not been described (Kohls 1956). This tick has been spotted in Valle del Cauca parasitizing rodents, but there are no new updates of this tick (Rivera-Paez *et al.* 2018a).

### ***Ixodes venezuelensis* Kohls, 1953**

This tick has been reported in Colombia, Costa Rica, Panama and Venezuela in marsupials and rodents (Barros-Battesti *et al.* 2006; Vásquez *et al.* 2011; Lopez 2017); some authors suggest that this species could reproduce by parthenogenesis and that the male does not attach to the host. Type: USNTC, BMNH (Barros-Battesti *et al.* 2006).

## **DISCUSSION**

Ticks (order Ixodida, superfamily Ixodoidea) are obligatory hematophagous ectoparasites and the main vectors of different zoonotic agents which represent a great concern worldwide. Despite the fact that Colombia is located between Central America and South America, and it has different habitats and biotypes, the studies regarding ticks' biodiversity are fragmented, isolated and unfortunately many localities have not been studied due to geographical conditions and political conflicts. The new political environment has created better conditions for medical personnel, researchers, and citizens to study different tick-borne-diseases associated with the presence of *Ehrlichia canis*, *Anaplasma platys*, *Anaplasma phagocytophilum* and *Babesia vogeli*. Each association is not completely understood and there is no evidence of the vector associated with some outbreaks. For this reason, it is important to update previous reports and to study our biodiversity systematically. Here, the risk that represents hard ticks (Acari, Ixodidae) in Colombia is described. The present review updates the species identified in Colombia and opens a door to future studies in order to characterize the tick biodiversity and ticks as-disease vectors.

In Colombia, 47 hard tick species have been reported in the literature. Most of the tick records for Colombia come from the studies of Osorno-Mesa (1942), which took place more than 50 years ago. The knowledge of these Neotropical ticks and tick-borne diseases has experienced a remarkable growth, with modern morphological, ecological, epidemiological and molecular tools, including the identification of different associated agents. Most of the tick collections are deposited in: Zoologisches Staatsmuseum Hamburg, Hamburg, Germany (ZMB); Institute Oswaldo Cruz, Rio de Janeiro, Brasil (IOC); United States National Museum of Natural History (Smithsonian Institution); United States National Museum (USNTC), Washington, U.S. (USNM); Gorgas Memorial Laboratory, Panama city (GML); School of National Veterinary, Toulouse, France (ENV); The Natural History Museum, London, England (BMNH); and National Tick Collection (CNC) at the Faculty of Veterinary Medicine and Zootechniques (FMVZ) of the University of Sao Paulo (USP). In Colombia, there are a number of tick repositories: Museo de Historia Natural de la Salle, The Teaching Collection (CD) of the Zoology Department of the Universidad del Valle (Cali), and the Entomological Collection at the Universidad Nacional de Colombia Sede Palmira (CEUNP) and the Corporación para estudios en la salud (CES). The distribution of tick populations in Colombia might be constantly affected by the establishment of different cattle farms and crops that have transformed the ecosystems as well as bird and mammal migrations. In regions such as Valle del Cauca, the majority of the farms are located in lower montane rainforest areas, with temperature and elevation within a range of 20–28 °C, 650–980 m a.s.l., with relative humidities of 70–80%. In some areas, the prevalent vegetal species are bamboo (*Guadua angustifolia* Kunth, 1822), different types of forests, pastures (*Brachiaria decumbens*, Star Grass), protein bank (*Trichanthera gigantea*), and sugarcane (*Saccharum officinarum*). The social activity of local inhabitants has transformed the lands through the growth of regional products such as cassava (*Manihot esculenta*), maize (*Zea mays*), sugarcane, and bananas (*Musa acuminata*) as well as

different pastures. Colombia has different systems of production: *minifundios* (smallholding) and *latifundios* (landholdings); most of them focus on the production of milk from cattle and sheep, in association with other domestic animals such as *C. lupus familiaris*, cats, chicken, horses and mules for labor activities. In Colombia, the species of ticks associated with domestic animals (*B. taurus*, *Equus caballus* and *Canis familiaris*) are 52.9% *R. (B.) microplus* and 32.8%, *D. nitens*, which is consistent with previous studies in cattle farms not associated with protected areas or conservation areas, where 79% were *R. (B.) microplus*, 17% *D. nitens*, 3.4% *A. cajennense* and 0.8% *R. sanguineus* (Benavides *et al.* 2009).

When studies aimed to describe the species of ticks infesting bovine animals and horses in the South of the Colombian Pacific coast, located at 2 m a.s.l., 28 °C of temperature and 82–87% relative humidity, the biodiversity was found to be as low as *R. (B.) microplus* 99.94% and *A. nitens* 0.06% (Arias *et al.* 1991). Regarding other regions of Colombia, Betancourt identified *R. (B.) microplus* in 100% of the samples in a study developed in cattle of four municipalities of North Antioquia (López *et al.* 1985). In Valle de Aburrá (Antioquia), the same tendency was reported with 99.7% *R. (B.) microplus*, 0.16% *A. nitens*, 0.12% *R. sanguineus* and even lower percentage for *A. cajennense* (Hernández and Valero 1977); however, when studies sampled domestic and wild animals on the border of protected areas, the tick diversity greatly increased in the different species of mammals, as follows: In cattle, *R. (B.) microplus*, *A. nitens*, *A. cajennense* and *A. coelebs*; in horses, *R. (B.) microplus*, *A. nitens*, *A. cajennense* and *A. neumanni*; in alpacas, *A. nitens*; in dogs, *R. sanguineus*, *A. ovale* and *A. parvum*; in bufalos, *A. cajennense*; in marsupials, *A. ovale* and *I. luciae*; in nutrias, *A. dissimile*, in amphibians; *A. nodosum*, in anteaters (Lopez Valencia and Parra Danilo 1985). Similar results were reported in the Valle del Cauca, with 11 species among the genus *Rhipicephalus* Koch, 1844, *Dermacentor* Koch, 1844, *Amblyomma* Koch, 1844 and *Ixodes* Latreille, 1795 (Benavides-Montaño *et al.* 2018).

Finally, the authors emphasize the need to further study Colombia's tick biodiversity and tick-borne diseases on mammals, reptiles and birds, in association with a constant monitoring of weather patterns, deforestation and fragmentation processes. There is also a need to characterize the effects of extreme climate events that could change the biodiversity and expand the range and risk of different pathogens that affect not only domestic and wild animals, but human populations (Etter *et al.* 2006; Ricaurte *et al.* 2017).

## CONCLUSIONS

The present work aimed to condense and update the reports on hard ticks in Colombia and motivate Colombian acarologists and parasitologists to advance in the knowledge of tick taxonomy, ecology distribution and host-parasite interaction. It is necessary to expand the tick collections already available in Colombia in order to match those residing in foreign countries. This would favor the development of knowledge about Colombian biodiversity. Future analyses are required to explain the presence of ticks in different environmental and ecological niches. Finally, the studies on biodiversity require support from governmental environmental institutions to sensitize and educate communities on the importance of studying tick-borne diseases, protecting wildlife ecosystems, and minimizing the risk of tick-borne-diseases. As far as it is known, there is not a comprehensive study on ticks of Colombia and the sporadic information is related to disease transmission. Therefore, future studies on the ecology of ticks and epidemiology of tick-borne diseases in Colombia will be rewarding. Veterinarians and researchers should be encouraged, not only to update the list of prevalent ticks and their vector capability but focus on a better understanding of the epidemiology of tick-borne human and animal diseases.

Note: For *Amblyomma auricularium*, *A. calcaratum*, *A. coelebs*, *A. geayi*, *A. goeldii*, *A. humerale*, *A. incisum*, *A. longirostre*, *A. multipunctum*, *A. naponense*, *A. neumanni*, *A. oblongoguttatum*, *A.*

*pacae*, *A. pecarium*, *A. sculpturatum*, *A. tigrinum*, *A. triste*, *A. tapirellum*, *A. varium*, *H. juxtakochi*, *D. imitans*, *Ixodes* species namely *I. venezuelensis*, *I. tropicalis*, *I. tapirus*, *I. pararicinus*, *I. montoyanus*, *I. luciae*, *I. loricatus*, *I. lasallei*, *I. fuscipes*, *I. brunneus*, *I. boliviensis*, *I. bocatorensis*, *I. andinus*, *I. affinis*, *I. auritulus* new updates, geographic distribution, ecology and pathogenic role in animals and humans are required as well as future studies in order to validate its presence or categorize the sporadic or casual events in Colombia as well as to strengthen the tick collections related to these species.

### CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

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## مروری بر کنه‌های سخت (Acari: Ixodidae) در کلمبیا: خطر بیماری‌های منتقله از طریق کنه

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### چکیده

این مقاله به مرور گونه‌های ایکسودید در کلمبیا می‌پردازد. پایگاه‌های اطلاعاتی مختلف ۵۰ گونه از کنه‌ها را گزارش کردند که از میان آنها ۲۹ گونه متعلق به *Amblyomma* هستند: *A. auricularium* (*s.l.*)، *A. cajennense*، *A. coelebs*، *A. calcaratum*، *A. triste*، *A. tigrinum*، *A. maculatum*، *A. longirostre*، *A. humerale*، *A. goeldii*، *A. geayi*، *A. dissimile*، *A. crassum*، *A. pacae*، *A. ovale*، *A. oblongoguttatum*، *A. nodosum*، *A. neumanni*، *A. naponense*، *A. multipunctum*، *A. mixtum*، *A. incisum*، *A. varium*، *A. tapirellum*، *A. scalpturatum*، *A. sabanerae*، *A. rotundatum*، *A. patinoi*، *A. pecarium*، *R. (Boophilus) microplus*، *Rhipicephalus* دو گونه *H. leporispalustris*، *H. juxtakoch*، *Haemaphysalis* دو گونه *R. sanguineus s.s.*، *D. imitans*، *Anocentor (D.) nitens*، *I. andinus*، *I. affinis*، *Ixodes* دو گونه *I. montoyanus*، *I. luciae*، *I. loricatus*، *I. lasallei*، *I. fuscipes*، *I. brunneus*، *I. boliviensis*، *I. bocatorensis*، *I. auritulus*، *I. venezuelensis*، *I. tropicalis*، *I. tapirus*، *I. pararicinus* عنوان تهدیدی برای سلامت انسان و حیوان مورد مطالعه قرار گیرد. بنابراین، بررسی سراسر کشوری کنه‌های Ixodidae برای به‌روزرسانی اطلاعات ارائه‌شده در این کار، ارزش زیادی دارد.

واژگان کلیدی: امریکا؛ تنوع زیستی؛ فهرست؛ سلامت؛ Ixodida؛ ناقل.

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