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Ticks collected from humans, domestic animals, and wildlife in Yucatan, Mexico

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ABSTRACT

Domestic animals and wildlife play important roles as reservoirs of zoonotic pathogens that are transmitted to humans by ticks. Besides their role as vectors of several classes of microorganisms of veterinary and public health relevance, ticks also burden human and animal populations through their obligate blood-feeding habit. It is estimated that in Mexico there are around 100 tick species belonging to the Ixodidae and Argasidae families. Information is lacking on tick species that affect humans, domestic animals, and wildlife through their life cycle. This study was conducted to bridge that knowledge gap by inventorying tick species that infest humans, domestic animals and wildlife in the State of Yucatan, Mexico. *Amblyomma* ticks were observed as euryxenous vertebrate parasites because they were found parasitizing 17 animal species and human. *Amblyomma mixtum* was the most eryxenous species found in 11 different animal species and humans. Both *A. mixtum* and *A. parvum* were found parasitizing humans. *Ixodes* near *affinis* was the second most abundant species parasitizing six animal species (dogs, cats, horses, white-nosed coati, white-tail deer and black vulture) and was found widely across the State of Yucatan. Ixodid tick populations may increase in the State of Yucatan with time due to animal production intensification, an increasing wildlife population near rural communities because of natural habitat reduction and fragmentation. The diversity of ticks across host taxa documented here highlights the relevance of ecological information to understand tick–host dynamics. This knowledge is critical to inform public health and veterinary programs for the sustainable control of ticks and tick-borne diseases.

1. Introduction

Wildlife and domestic animals play important roles as reservoirs of zoonotic pathogens that are transmitted to humans by ticks (Morse, 1995). Besides their role as vectors of several classes of microorganisms of veterinary and public health relevance (Morse, 1995; Jongejan and Uilenberg, 2004), ticks also burden human and animal populations through their obligate blood-feeding habit (Ostfeld et al., 2006). Tick feeding causes irritation, skin inflammation, pruritus, self-wounding, stress, and allergic responses (Wall and Shearer, 2001). The world's tick fauna comprises around 900 species, which are grouped under three families, Ixodidae, Argasidae and Nuttalliellidae (Guglielmone et al., 2010) and are distributed worldwide as parasites of terrestrial vertebrates (Nava et al., 2009). It is estimated that in Mexico there are 100 tick species belonging to the Ixodidae and Argasidae families (Pérez et al., 2014).

Several emerging and re-emerging tick-borne diseases have a wildlife species as their reservoir (Daszak et al., 2001; Kate et al., 2008; Pérez de León et al., 2014b). The development of improved strategies to mitigate the burden of zoonotic tick-borne diseases requires a better understanding of the biology and ecology of ticks, including the role of wildlife species as tick hosts and the epidemiology of tick-borne pathogens (Estrada-Peña et al., 2013; Ogden et al., 2013; Esteve-Gassent et al., 2014). Scientific progress is advancing our understanding of tick host specificity. Some tick species are host generalists and can feed on different vertebrate species depending on their availability and abundance (Wilson et al., 1984; Anderson, 2002), whereas other species may be more specific and use

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a narrow host range (Guglielmone et al., 2014). Many ticks parasitize domestic animals but few ticks feed exclusively on them as most tick species may also parasitize wild animals. Wild and domestic cycles are often complementary. Immature tick stages that parasitize wild and peridomestic animals can feed later as adults on domestic animals (Ruiz-Fons and Gilbert, 2010). However, it has been proposed that a more ecological view of tick-host associations at the local scale is required to better understand the implications of tick-host-pathogen interactions for the epidemiology, and control of zoonotic tick-borne diseases (McCoy et al., 2013; Ogden et al., 2013).

Studies examining the diversity of ticks parasitizing human, domestic animals, and wildlife in Mexico are scarce. It is important to describe the tick fauna parasitizing domestic animals and wildlife because several of these tick species can also parasitize humans and are reservoirs of zoonotic pathogens. Enhanced knowledge of tick spatial and temporal distributions can translate into improved local and regional tick control programs. Records of tick species infesting human, domestic animals, and wildlife in Yucatan, Mexico are reported here. The veterinary public health implications of these findings are discussed.

2. Materials and methods

2.1. Study area

The study was carried in 17 municipalities in Yucatan State, Mexico between January 2009 to December 2014. Because domestic and wild animals were not sampled during all seasons of the year, some tick species or tick stages may not be represented due to the differences in seasonal activity among tick species and tick stages. The climate of the State is sub-humid tropical with a summer rainy season. The monthly maximum temperature varies from 35° to 40 °C (mean 26.6 °C). The relative humidity (RH) varies from 65 to 100% (mean 80%) and the annual rainfall varies from 415 mm to 1290 mm depending on the area (INEGI, 2002).

2.2. Tick collection

Ticks were collected from humans and six domestic animal species: cat (*Felis silvestris catus*), sheep (*Ovis aries*), dog (*Canis lupus familiaris*), goat (*Capra hircus*), cattle (*Bos indicus*/*Bos taurus*), and horse (*Equus caballus*). The 13 wildlife species inhabiting the region under study that were sampled to determine tick infestation included reptiles, birds, and mammals. The reptile species sampled were: crocodile (*Crocodylus acutus*), box turtle (*Terrapene carolina mexicana* and *T. c. yucatana*), snake (*Boa constrictor*), black spiny-tailed iguana (*Ctenosaura similis*). Black vultures (*Coragyps atratus*) were the bird species inspected for ticks. Mammal species surveyed included white-tailed deer (*Odocoileus virginianus*), red deer (*Cervus elaphus*), collared peccari (*Pecari tajacu*), northern tamandua (*Tamandua mexicana*), mouse (*Mus musculus),* eastern cottontail rabbit (*Sylvilagus floridanus*), skunk (*Spilogale angustifrons*), and white-nosed coati (*Nasua narica*).

Animals and humans were sampled as follows:

Dogs and cats: Animals were inspected visually for ticks, which were also detected by running one's hand across the dog or cat body.

Ruminants and horses: We inspected the head, neck, ears, and ventral surface of animals for tick collection. All visible ticks were manually removed from the body of the infested animals.

Red deer: Because the head and neck are the primary sites of tick attachment (Rodriguez-Vivas et al., 2013a,b), deer were inspected from the top of the head, just rostral to the ear, posteriorly to the scapula, and from the ventral midline to the dorsal midline of the neck. Ticks were removed manually from the animals.

Mice: Mice were captured by using Sherman traps (Sherman Traps Inc., Tallahassee, Florida, USA) baited with a mixture of oats and vanilla extract. Traps were located in houses at rural communities. The entire body of each rodent was thoroughly examined for ticks by visual inspection and with the aid of a comb.

Wildlife: Most of the wild animals were sampled after being hunter-harvested, or killed on highways (Haemig et al., 2008). Hunter-harvested animals were preserved in sealed plastic bags and transported to the laboratory. The sealed plastic bags allowed the collection of ticks detaching from the carcass. Animals found dead on roads were also transported to the laboratory in sealed plastic bags. Dead animals and container plastic bags were thoroughly inspected in the laboratory for ticks. Ticks were removed manually from dead animals.

Human: Ticks were obtained manually from people that were incidentally bitten and voluntarily went to our laboratory for consented tick removal.

All collected ticks were transferred to 50 ml vails containing ethanol 70%. Specimens were taken to the Parasitology Laboratory at the Biological Sciences and Husbandry Campus of the Autonomous University of Yucatan (CCBA-UADY) for taxonomic identification. Ticks were identified to species, developmental stage, and sex, in the case of adults, under a dissecting microscope using conventional taxonomic keys (Guglielmone and Nava, 2010; Guzmán-Cornejo et al., 2007; Guzmán-Cornejo and Robbins, 2010), and morphological comparison with available identified specimens in the United States National Tick Collection of Georgia Southern University (USNTC) at The James H. Oliver, Jr. Institute for Coastal Plain Science, Georgia Southern University, Statesboro, GA. Ticks were examined with a stereomicroscope (Olympus SZX16, Olympus Corporation). Identified specimens were deposited at the USNTC, and at the Parasitology Laboratory, CCBA-UADY.

The most abundant and widest distributed ticks were georeferenced at collection localities and this information was displayed on maps of Yucatan State. Guides by Campbell (1998), Reid (2009), and Canseco-Marquez and Gutierrez-Mayen (2010) were used as references for the specific and common names of the domestic animals and wildlife species examined.

3. Results

A total of 956 Ixodidae ticks were collected from six species of domestic animals ($n = 807$), 13 species of wild animals ($n = 110$), and humans ($n = 39$), from Yucatan State, Mexico. There were 15 different hard tick species belonging to the genera *Amblyomma*, *Ixodes*, *Rhipicephalus*, *Dermacentor*, and *Haemaphysalis*.

Ten hard tick species were collected from domestic animals (*A. mixtum*, *A. ovale*, *A. maculatum*, *A. sabanerae*, *A. auricularium*, *A. parvum*, *I.* near *affinis*, *Rhipicephalus sanguineus* sensu lato, *Rhipicephalus microplus*, and *D. nitens*) (Table 1). An equal number of ixodid tick species were obtained from wild animals (*A. mixtum*, *Amblyomma rotundatum*, *A. nodosum*, *A. sabanerae*, *A. scutatum*, *A. parvum*, *Haemaphysalis juxtakochi*, *Haemaphysalis leporispalustris*, *Rhipicephalus microplus*, and *I.* near *affinis*) (Table 2). Four tick species were found to be infesting humans (*A. parvum*, *A. mixtum*, *Rhipicephalus sanguineus* s.l., and *R. microplus*) (Table 3) (Figs. 1 and 2).

The genus *Amblyomma* was detected in 17 animal species and humans. The most common tick species in animals (dogs, goat, sheep, cattle, horse, crocodile, northern tamandua, peccary, box turtle, red deer, white-tailed deer) and humans was *A. mixtum*, followed by *I.* near *affinis* (dogs, cats, horses, black vulture, white-tailed deer and white-nosed coati), *A. parvum* (dog, cat, black vulture, white-tailed deer, mouse and human), *R. microplus* (cattle,