Ticks of New World Tapirs

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Abstract

In this paper, we present an updated list of ticks that have been found infesting New World tapirs. For this purpose, literature records were obtained from the INTA tick database. Data are presented according to tick species, tapir species, and country. A total of 27 tick species have been reported infesting New World tapirs. Most of the reports were on *T. terrestris* (20 tick species in 10 countries). Thirteen tick species were reported on *T. bairdii* in 3 countries, and only 2 tick species on *T. pinchaque* in 2 countries. Ticks reported on tapirs comprised 18 species of the genus *Amblyomma*, and 7 other species representing the genera *Ixodes*, *Haemaphysalis*, *Dermacentor*, and *Rhipicephalus* from the Ixodidae family, and at least 2 *Ornithodoros* species from the Argasidae family. Indeed, tapirs are very significant hosts for the Neotropical tick fauna. Since tapirs are usually found in less fragmented biomes with high biodiversity, and the richness of tick species is higher in tapirs than any other Neotropical vertebrate species, further studies are needed to evaluate the role of tapir-associated ticks on biodiversity. The role of these ticks on tick-borne diseases for tapir and other vertebrates also needs further investigations.

Keywords: ecology, Ixodida, Neotropical tapirs, parasites, ticks

Introduction

Ticks are obligate hematophagous ectoparasites, belonging to the class Arachnida, order Acari, and are divided into three families: (i) Ixodidae (hard ticks), the largest family, composed of 13 genera and 692 species; (ii) Argasidae (soft ticks), composed of 5 genera and 186 species; (iii) and Nuttalliellidae, a monotypic family composed of the species *Nuttalliella namaqua* (Nava *et al.*, 2009), although this arrangement is not universally accepted. In the Neotropics, there are 194 valid tick species (115 Ixodidae and 79 Argasidae) (Guglielmone *et al.*, 2003, Estrada-Peña *et al.*, 2004a, Labruna *et al.*, 2005a, 2008, Venzal *et al.*, 2008).

Ticks are responsible for vectoring a variety of pathogens (including virus, bacteria, protozoon and helminthes) to humans and animals (Guglielmone *et al.*, 2003). In fact, it has been reported that ticks are vectors of more kinds of microorganisms than any other single arthropod taxon, including mosquitoes (Oliver, 1989). Most of the ticks of medical and veterinary importance are within the Ixodidae family. Thus, studies on these ticks have been much more frequent than on Argasidae ticks. Of the 115 Ixodidae tick species established in the Neotropical region, 58 (50.4%) belong to the genus *Amblyomma.* In South America alone there are 53 established *Amblyomma* species, which represent almost half of the 129 *Amblyomma* species occurring in the world (Guglielmone *et al.*, 2003, Nava *et al.*, 2009). Indeed, South America bears the largest diversity of *Amblyomma* species in the world.

During the life cycle, Ixodidae ticks undergo four stages: eggs, larvae, nymphs, and adults. They have only one nymphal instar, in contrast to the several nymphal instars of Argasidae. Usually, all stages (except eggs) need a blood meal for further development. Ixodidae also differ from Argasidae in that each stage requires several days or longer to engorge with blood, and they also require larger blood meals (Oliver, 1989). For completion of the life cycle, ticks undergo a parasitic phase – when they feed on a vertebrate host that can be amphibians, reptiles, birds or mammals, depending on the tick species – and a free-living phase – when they are in the environment for molting, egg deposition and incubation, or just waiting for a host. For development to the next stage, most ticks feed as one stage (eg. larva) and then undergo ecdyse (molting) in the environment. Ixodidae females feed only once, produce one large egg mass of thousands of eggs, and die. Argasidae females lay several small egg masses of dozens to hundreds of eggs, with a blood meal preceding each eggs mass. A few tick species ecdyse on the host, going to the environment for egg laying. Generally, when ticks are feeding on the host, their survivorship is mostly affected by host innate and acquired (immunologic) defenses. On the other hand, when ticks are at free-living stages, they do not feed and their survivorship is mostly affected by variations in environmental temperature and relative humidity. Most of the Neotropical ticks require cool temperatures (between 18 to 28ºC) and high relative humidity (>80%) for successfully development in the environment. Usually, ticks from dense rainforests require higher relative humidity (>95%) for free-living development than ticks from less humid biomes, such as Cerrado and Chaco.

Given the numerous pathogens ticks transmit and their blood-feeding habits, most people would instinctively think that ticks are of no benefit for nature (Durden & Keirans, 1996). However, ticks (and other parasites) are an integral component of healthy ecosystems and have important roles in nature, some of which may be still incompletely understood. Ectoparasites, like ticks, exert selective pressure on host populations and are at least responsible for maintaining high levels of genetic diversity in their hosts when compared with nonparasitized animals, and help to eliminate weaker or susceptible host individuals in nature, thereby maintaining a healthier host population (Durden & Keirans, 1996). Some tick species also represent important food source for a few bird species; thus, dramatic extinction of ticks from a given area could affect these bird species, as has been shown in some parts of Africa (Bezuidenhout & Stutterheim, 1980). For a direct anthropic point of view, ticks are proving to be a storehouse of useful biochemicals (Durden & Keirans, 1996). For example, various pharmaceutically active compounds have been isolated from tick saliva, with antiplatelet, antihemostatic, anti-inflammatory, immunosuppressive, or antimicrobial properties (Durden & Keirans, 1996, Ribeiro *et al.*, 2006).

Among the four species of Tapirs in the world, three occur exclusively in the New World. These are *Tapirus terrestris* (low land tapir), *Tapirus bairdii* (Baird's tapir), and *Tapirus pinchaque* (mountain tapir). *T. terrestris* occurs through a wide geographic range from North-Central Colombia and east of the Andes throughout most of tropical South America. It occurs mostly in tropical lowland rainforest but can also be found in seasonally dry habitats such as the Brazilian Cerrado and Chaco of Bolivia and Paraguay. *T. bairdii* is distributed from Oaxaca Province in Mexico through Central America to the western side of the Andean mountain range in Colombia (the Darien). It occurs in rainforests, lower montane forests, deciduous forests, flooded grasslands and marsh areas. *T. pinchaque* is restricted to Montane forests and Paramos in Colombia, Ecuador and northern Peru, between 2000 to 4000 meters elevation (data from http://www.tapirs.org/tapirs/index.html, where geographic distribution maps of tapirs are available). In this paper, we present an updated list of ticks that have been found infesting New World tapirs, and discuss how important these animals are for New World ticks.

Material and Methods

Literature records of ticks on New World tapirs were obtained from the INTA tick database. This database was created in the year 2000 and has been maintained since then by one of the authors (A.A.G.) with information compiled from literature for records of ticks from the Neotropical region. Data are presented according to tick species, tapir species, and country. Some literature records for ticks on tapirs did not specify the *Tapirus* species. In this case, we deduced the species by consultation the geographical distribution of New Word tapirs published by Emmons & Feer (1997) and that available at http://www.tapirs.org/tapirs/index.html. For most tick species, there are more than one literature report on a given tapir species in an individual country. In this case, we considered only one literature report since our intention is to provide a distribution according to country, with no indication of number of reports per country.

Results and Discussion

As shown in Table 1, a total of 27 tick species have been reported infesting New World tapirs. Most of the reports were on *T. terrestris* (20 tick species). Thirteen tick species were reported on *T. bairdii*, and only two tick species on *T. pinchaque*. A high number of tick species was expected for *T. terrestris* since this tapir is largely distributed in almost the entire South America. The low number of tick species recorded for *T. pinchaque* was also expected since this species has a narrow distribution area restricted to high lands between 2000 to 4000 meters elevation, besides being less studied than the remaining tapir species. Among the 27 ticks species reported on tapirs, the majority [18 species (66.7%)] belonged to the genus *Amblyomma*, which is also expected as this genus comprises most of the New World tick species. Dunn (1934) found *A. humerale* on tapirs in Panama, but Fairchild et al. (1966) consider this tick to be *A. sabanarae*. This contradictory finding was not included in our list of ticks from tapir.

In addition to the 18 species of the genus *Amblyomma* reported on tapirs, there are 7 other species representing the genera *Ixodes*, *Haemaphysalis*, *Dermacentor*, and *Rhipicephalus* from the Ixodidae family, and at least 2 species from the Argasidae family (*Ornithodoros rudis* and *Ornithodoros tuttlei*). However, while the number of tick species reported infesting tapirs in each country vary widely, it is quite possible that this variation is due to incomplete records. Most of the tick species are found across *Tapirus* spp range and have simply not yet been recorded on tapirs. For example, almost all tick records on *T. bairdii* are from Panama, however *T. bairdii* occurs in other countries as well. This result is certainly biased to the high number of studies that have been done with ticks of Panama (Fairchild *et al.,* 1966).

Tick-tapir ecology

In nature, ticks are found parasitizing practically all land vertebrate species. In South America, individuals of most vertebrates are found infested by a single tick species at any point in time, although a few species are commonly found infested by two species. Rarely, three different tick species are found on a single host at the same time (Neiva & Penna, 1916, Aragão, 1918, 1936, Barros & Baggio, 1992). Tapirs are a great exception to this rule, since most animals are commonly found to be infested by 3 to 5 tick species, sometimes reaching 7 species (Aragão, 1936, Dun, 1934, Boero & Prossen, 1960, Labruna *et al.,* 2005b). No other vertebrate animal in the Neotropical region is found harboring so many tick species under natural conditions. This fact shows how important tapirs are for the biodiversity of ticks. The following 3 reasons could be related to the richness of tick species on tapirs: (i) natural tapir populations are usually established in high biodiversity-biomes with low anthropogenic activity (Bodmer & Brooks, 1997), favoring richness of tick species, as for example in the Amazon and Atlantic rainforest biomes; (ii) tapirs have large home ranges (Foerster & Vaughan, 2002), favoring direct contact with different tick species in a given area; (iii) *T. bairdii* and *T. terrestris* are the largest land vertebrates of the native Neotropical fauna (Emmons & Feer, 1997); it has been shown for other mammals that tick parasitic load is positively correlated to body size (Mohr, 1961), thus, as more ticks infest a tapir, greater should be the chances of finding different species.

Most of the tick species associated with tapirs (Table 1) are known as ambush ticks. Ambush ticks wait on the tips of leaves, waiting for the passage of a suitable host, i.e., tapirs (Sonenshine, 1991). Notably, ticks are known to be capable of surviving for months or years in the environment without having a blood meal (Oliver, 1989). Thus, the successful establishment of ambush ticks in a given area will basically depend on two factors: (i) primary host density – the higher the host density, the higher the probability of a chance contact between primary host and the ticks; (ii) environmental suitability – suitable environment is where free-living stages of ticks encounter favorable microclimatic conditions for survivorship and development. Both primary host density and environmental suitability are inter-related and can be extremely variable in different habitats. This interaction will determine tick presence/absence and abundance. For example, highly suitable environments with low host density could support tick populations similar to poorly suitable environments with high host density. On the other hand, highly suitable environments with high host density would result in the largest tick populations; conversely, ticks might be absent from areas with poorly suitable environments with low host density.

Typically, tapirs are solitary individuals but several individuals can use the same area; they have very well established home ranges, but do not seem to be territorial due to high percentages of home range overlap between neighboring individuals (Medici *et al.,* 2006). Since tapirs travel widely through their habitat (large home range), even low tapir densities favor ambush ticks. Tapir paths are frequent where tapirs occur. These paths are usually used by other mammals, such as peccaries and deer (Emmons & Feer, 1997), and thus participate in the life-history of most tapir-associated ticks; and vice-versa.

Since *T. terrestris* is distributed in most of the major biomes of South America (eg. Amazon, Atlantic Rainforest, Pantanal, Cerrado, and Chaco) (Emmons & Feer, 1997), the diversity of ticks parasitizing tapirs in these different biomes depends on the adaptation of ticks to each of these biomes. For example, *Amblyomma cajennense* is a typical Savannah tick, commonly found parasitizing tapirs in the Cerrado and the Pantanal, but very rarely found in the Amazon or primary Atlantic Rainforest (Estrada-Peña *et al.,* 2004b, Labruna *et al.,* 2005b). However, its distribution has expanded into areas where the original Atlantic Rainforest biome has been degraded or replaced by livestock pastures resembling savannah (Estrada-Peña *et al.,* 2004b, Labruna *et al.,* 2005b). Conversely, *A. incisum*, *A. scalpturatum* and *A. latepunctatum* are typical of large patches of primary Amazon or Atlantic Rainforests (Labruna *et al.,* 2005a), and practically absent from other biomes. These differences in biogeographic distribution are intimately related to the microclimatic conditions required by each tick species within its distribution. A unique example is *Ixodes tapirus,* for which its free-living stages are well adapted to low temperatures prevailing in high land mountain forests of Panama and Colombia (Fairchild *et al.,* 1966). At least in Colombia, this tick occurs within the distribution area of *T. pinchaque,* a primary host for *I. tapirus.*

Table 1. Ticks reported on New World tapirs. For each country record, a reference is provided in parentheses.

No.	Tick species	Countries with records on *Tapirus terrestris*	Countries with records on *Tapirus bairdii*	Countries with records on *Tapirus pinchaque*	Additional countries where the tick species was reported but not on tapirs [+]
1	*Amblyomma brasiliense*	Brazil (Aragão 1936)			Argentina, Paraguay
2	*Amblyomma cajennense**	Argentina (Guglielmone & Nava 2006), Brazil (Aragão 1913), British Guyana (Tonelli-Rondelli 1937), French Guyana (Floch & Fauran 1959), Paraguay (Tonelli-Rondelli 1937), Surinam Keirans 1985), Venezuela (Jones et al. 1972)	México (Dugès 1891), Panama (Dunn 1934)		Southern United States, Mexico, remaining Central American countries, Caribbean, and the remaining South American countries (except for Chile and Uruguay)
3	*Amblyomma calcaratum*	Brazil (Keirans 1982)			Argentina, Belize, Bolivia, Colombia, Costa Rica, Ecuador, French Guyana, Panama, Paraguay, Peru, Surinam, Trinidad & Tobago, Venezuela,
4	*Amblyomma coelebs**	Argentina (Guglielmone & Nava 2006), Bolivia (Robinson 1926), Brazil (Aragão 1936), British Guyana (Tonelli-Rondelli 1939), French Guyana (Floch & Fauran 1959), Peru (Mendonza-Uribe & Chavez-Chorocco 2004), Surinam (Keirans 1985), Venezuela (Jones et al. 1972)	Costa Rica (Hernadez-Divers et al. 2005), Mexico (Cruz-Aldán et al. 2006), Panama (Dunn 1934)		Belize, Colombia, Guatemala, Honduras, Nicaragua, Paraguay
5	*Amblyomma dubitatum*	Argentina (Zerpa et al. 2003a), Brazil (Robinson 1926)			Bolivia, Paraguay, Uruguay
6	*Amblyomma incisum**	Bolivia, Brazil, Peru [#]			Argentina, Paraguay [#]
7	*Amblyomma latepunctatum**	Brazil, British Guyana, Ecuador, Peru, Venezuela [#]			French Guyana [#]
8	*Amblyomma multipunctum**	Bolivia (Boero & Prosen 1959), Venezuela (Robinson 1926)		Colombia (Kohls 1956b), Ecuador (Voltzit 2007)	none
9	*Amblyomma naponense*	Brazil (Barros & Baggio 1992), French Guyana (Floch & Fauran 1959)			Bolivia, British Guyana , Colombia, Costa Rica, Ecuador, Panama, Peru, Surinam, Venezuela
10	*Amblyomma neumanni*	Argentina (Guglielmone & Nava 2006)			Colombia
11	*Amblyomma oblongoguttatum**	Brazil (Aragão 1936), British Guyana (Keirans 1985), French Guyana (Floch & Fauran 1959), Venezuela (Jones et al. 1972)	Costa Rica (Hernadez-Divers et al. 2005), Mexico (Chavarría 1941), Panama (Dunn 1934)		Belize, Bolivia, Guatemala, Nicaragua, Peru, Surinam
12	*Amblyomma ovale**	Argentina (Guglielmone & Nava 2006), Bolivia (Boero & Prosen 1955), Brazil (Aragão 1936), Ecuador (Zerpa et al. 2003b), French Guyana (Floch & Fauran 1959), Paraguay (Pallarés & Usher 1982),	Mexico (Cruz-Aldán et al. 2006), Panama (Dunn 1934)		Belize, British Guyana, Colombia, Costa Rica, Guatemala, Nicaragua, Surinam, Trinidad & Tobago

		Peru (Mendonza-Uribe & Chavez-Chorocco 2004), Venezuela (Jones et al. 1972)			
13	*Ambyomma pacae*		Mexico (Guzmán-Cornejo et al. 2006)		Belize, Brazil, British Guyana, Colombia, Panama, Paraguay, Surinam, Venezuela
14	*Amblyomma parvum*	Brazil (Aragão 1913)			Argentina, Bolivia, Colombia, Guatemala, Mexico, Nicaragua, Panama, Venezuela
15	*Amblyomma pseudoconcolor*	French Guyana (Floch & Fauran 1959)			
16	*Amblyomma scalpturatum**	Bolivia, Brazil, British Guyana, Colombia, Ecuador, Peru, Venezuela #			French Guyana, Surinam #
17	*Amblyomma tapirellum**		Panama (Dunn 1934)		Belize, Colombia, Nicaragua
18	*Amblyomma triste*	Brazil (Kohls 1956a), Paraguay (Nava et al. 2007)			Argentina, Colombia, Ecuador, Mexico, Peru, Uruguay, Venezuela
19	*Ixodes boliviensis*		Panama (Fairchild et al. 1966)		Bolivia, Colombia, Costa Rica, Guatemala, Honduras, Mexico, Peru
20	*Ixodes tapirus**		Panama (Fairchild et al. 1966)	Colombia (Kohls 1956b)	None
21	*Haemaphysalis juxtakochi*	Argentina (Guglielmone & Nava 2005), Brazil (Barros & Baggio 1992), Colombia (Kohls 1956a), French Guyana (Kohls 1956a), Venezuela (Jones et al. 1972)	Panama (Dunn 1934)		British Guyana, Costa Rica, Ecuador, Mexico, Panama, Paraguay, Surinam, Trinidad & Tobago, Uruguay
22	*Dermacentor halli*		Mexico (Cruz-Aldán et al. 2006)		Costa Rica, Guatemala, United States
23	*Dermacentor latus**		Costa Rica (Fairchild et al. 1966), Mexico (Cruz-Aldán et al. 2006), Panama (Fairchild et al. 1966)		none
24	*Dermacentor nitens*		Mexico (Cruz-Aldán et al. 2006),		In all American countries except for Canada, Chile, and Uruguay
25	*Rhipicephalus microplus*	Argentina (Ivancovich & Luciani 1992), Brazil (Labruna et al. 2005b), French Guiana (Floch & Fauran 1959), Paraguay (Nava et al. 2007)	Costa Rica (Cooley 1946)		In all American countries except for Canada and Chile, and various countries in Africa, Asia and Oceania
26	*Ornithodoros rudis*	Venezuela (Guerrero 1996)			Brazil, Colombia, Ecuador, Panama, Paraguay, Peru
27	*Ornithodoros tuttlei*	Venezuela (Jones et al. 1972)			none

* ticks for which tapirs are considered to be primary hosts.

[+] based on country records provided by Guglielmone et al. (2003) and additional records by López and Parra (1985), Cáceres et al. (2002), and Blair et al. (2004).

[#] Records on tapirs and geographic distribution of *A. incisum, A. latepunctaum*, and *A. scalpturatum* followed Labruna et al. (2005a).

Threatened tick species associated with tapirs

Tapirs are threatened in a large portion of their range, with several cases of local extinction caused primarily by habitat destruction (deforestation) and hunting (Costa, 1998, Moraes *et al.*, 2003). Since ticks depend on the availability of the vertebrate host, and a suitable environment for development and survival of free-living stages, extensive deforestation followed by tapir extinction are crucial factors leading to extinction of tapir-dependent tick species.

At least 18 (34%) of the 53 South American *Amblyomma* species have been associated with tapirs. In Table 1 we appoint that 9 of these *Amblyomma* species, plus 1 *Ixodes* and 1 *Dermacentor* species use tapirs as primary host – a primary host is the one considered to be amongst the most important hosts for a tick species to successfully feed on in a given area. Consequently, the occurrence of these tick species is intimately associated with the presence of tapirs in a given area. This dependence suggests that the extinction of tapirs from a given area would result in a drastic population reduction of these tick species, or in some cases, in tick extinction (coextinction). In fact, it has been shown that a number of tick species in the world are threatened with extinction (a few might have become extinct) due to drastic reduction of their primary host population and its corresponding habitat (Durden & Keirans, 1996).

Among the ticks that use tapirs as a primary host, some have additional mammalian primary hosts, but a few – including *Amblyomma coelebs, A. incisum, A. latepunctatum,* and *A. multipunctum* – seem to have only tapirs as its primary host under natural conditions, at least for the adult tick stage (Aragão, 1936, Labruna *et al.*, 2005a,b). Due to habitat requirements of the free-living stages, the above tick species have been restricted to well preserved forest areas, with the exception of *A. coelebs,* which is also found in secondary forest patches (Labruna *et al.*, 2005b). Thus, extensive deforestation, regardless of tapir presence, will culminate in the elimination or at least drastic reduction of these tick species. However, in some areas, in spite of habitat degradation, suitable conditions may still exist for the free-living stages. Nevertheless, the remaining habitat may not be able to support tapir populations, which could become locally extinct. Under these conditions, tick species would also be eliminated because their main source of food (tapirs) would not be available.

Ticks, tapirs and tick-borne diseases

While attached to their hosts, ticks secrete saliva that contains various substances responsible for neutralizing host homeostatic responses, allowing the tick to have a successful blood meal (Ribeiro *et al.*, 2006). Additionally, the saliva is also the main route of transmission of pathogens.

Most of the tapir-associated tick species shown in Table 1 are known to be human-biting ticks, with some of them being very aggressive to humans (Guglielmone *et al.*, 2006). Infestation normally occurs while walking on tapir paths (as mentioned above for other animals). In the Amazon region, humans are infested chiefly by *A. ovale, A. oblongoguttatum,* and *A. scalpturatum* (Labruna *et al.*, 2005b); in parts of the Atlantic rainforest, by *A. incisum* (Szabo *et al.*, 2006); in secondary forests, by *A. coelebs* and *A. cajennense*; in Savannah and Pantanal, chiefly by *A. cajennense* (Szabo *et al.*, 2007). All these ticks are tapir-associated, although not all of them use tapirs solely as primary hosts.

A. cajennense is the most aggressive human-biting tick in the central-eastern portion and in parts of the northern portion of South America. In some of these areas (Brazil and Colombia), *A. cajennense* has been incriminated as the main vector of the bacterium *Rickettsia rickettsii,* the etiological agent of the deadliest rickettsiosis of the world, named Rocky Mountain Spotted Fever (RMSF) (Labruna, 2009). Currently, all endemic areas for RMSF are degraded and devoid of tapirs, indicating that these animals do not play any significant role in the occurrence of RMSF. In the RMSF-endemic areas, horses, cattle, and/or capybaras act as primary hosts for *A. cajennense* (Labruna, 2009).

Several other *Rickettsia* species have been reported infecting most of the tapir-associated ticks in the Amazon and Atlantic rainforest areas, but with no zoonotic role reported so far (Labruna *et al.*, 2004). Regarding animals, studies on vector capacity of pathogens by these ticks to animals (including tapirs) are lacking, therefore, the role of tick-borne diseases on tapir conservation deserves further investigations.

Concluding remarks

Indeed, tapirs are very significant hosts for the Neotropical tick fauna. In this regard, tapir conservation will result in tick conservation. Most of the tapir-associated ticks have been poorly studied, thus their conservation is even more important. So far, there has been no indication of harmful effects of ticks on tapirs, nor has there been any record of tick-borne pathogens on tapirs. This scenario is probably linked to the absence of studies in this field. Since tapirs are usually found in less fragmented biomes with high biodiversity, and the richness of tick species is higher in tapirs than any other Neotropical vertebrate species, further studies are needed to evaluate the role of tapir-associated ticks on biodiversity. The role of these ticks on tick-borne diseases for tapir and other vertebrates also needs further investigations.

Acknowledgements

Thanks to Patricia Medici for critically reviewing the manuscript and the anonymous reviewer for his/her valuable suggestions to improve the manuscript. This work was supported by CNPq (Brazil) and INTA, CONICET and Asociación Cooperadora de la EEA-INTA Rafaela (Argentina).

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