

Ticks collected on birds in the state of São Paulo, Brazil

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Abstract The present study reports a collection of *Amblyomma* spp. ticks in birds from several areas of the state of São Paulo, Brazil. A total of 568 tick specimens (404 larvae, 164 nymphs) were collected from 261 bird specimens. From these ticks, 204 (36%) specimens (94 larvae, 110 nymphs) were reared to the adult stage, being identified as *Amblyomma longirostre* (94 larvae, 90 nymphs), *Amblyomma calcaratum* (13 nymphs), *Amblyomma nodosum* (2 nymphs), and *Amblyomma cajennense* (5 nymphs). Additionally, 39 larvae reared to the nymphal stage and 8 nymphs that died before reaching the adult stage were identified as *A. longirostre* according to peculiar characters inherent to the nymphal stage of this species: scutum elongate, and hypostome pointed. The remaining 271 larvae and 46 nymphs were identified as *Amblyomma* sp. Ticks were collected from 51 species of birds distributed in 22 bird families and 6 orders. The order Passeriformes constituted the vast majority of the records, comprising 253 (97%) out of the 261 infested birds. Subadults of *A. longirostre* were identified from 35 species of Passeriformes, comprising 11 families (Cardinalidae, Dendrocolaptidae, Fringillidae, Furnariidae, Parulidae, Pipridae, Thamnophilidae, Thraupidae, Turdidae, Tyrannidae, and Vireonidae), and from 1 species

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of a non-passerine bird, a puffbird (Bucconidae). Subadults of *A. calcaratum* were identified from 5 species of Passeriformes, comprising 5 families (Cardinalinae, Conopophagidae, Pipridae, Thamnophilidae and Turdidae). Subadults of *A. nodosum* were identified from 2 species of Passeriformes, comprising two bird families (Thamnophilidae and Pipridae). Subadults of *A. cajennense* were identified from 2 species of non-passerine birds, belonging to 2 different orders (Ciconiiformes: Threskiornithidae, and Gruiformes: Cariamidae). Birds were usually infested by few ticks (mean infestation of 2.2 ticks per bird; range: 1–16). Currently, 82 bird species are known to be infested by immature stages of *A. longirostre*, with the vast majority [74 (90%)] being Passeriformes. Our results showed that Passeriformes seems to be primary hosts for subadult stages of *A. longirostre*, *A. calcaratum*, and *A. nodosum*. However, arboreal passerine birds seem to be the most important hosts for *A. longirostre* whereas ground-feeding passerine birds seem to be the most important for both *A. calcaratum* and *A. nodosum*. In contrast, the parasitism of birds by subadults of *A. cajennense* has been restricted to non-passerine birds.

Keywords Ticks · Birds · *Amblyomma longirostre* · *Amblyomma calcaratum* · *Amblyomma nodosum* · *Amblyomma cajennense*

Introduction

The tick fauna of Brazil is currently composed by 56 recognized species. Most of these species belong to the genus *Amblyomma* (33 valid species), followed by the genus *Ixodes* (8 species). The remaining 15 species are divided into the genera *Argas* (1 species), *Ornithodoros* (5), *Antricola* (3), *Haemaphysalis* (3), *Dermacentor* (1), *Rhipicephalus* (1), and *Boophilus* (1) (Guimaraes et al. 2001; Barros-Battesti et al. 2006). The *Antricola* and some of the *Ornithodoros* species occurring in Brazil have been reclassified into the genus *Carios* (Klompfen and Oliver 1993), however this proposal has not been accepted by taxonomists from Latin America (Barros-Battesti et al. 2006). Despite of a relative large tick fauna, information about ticks infesting birds in Brazil is scanty.

Currently, only three tick species from Brazil are known to use birds as primary hosts for all parasitic stages: *Argas miniatus*, a parasite of the domestic fowl, and *Ixodes auritulus* and *Ixodes paranaensis*, which are parasites of several bird orders, mostly Passeriformes (Aragão 1936; Arzua et al. 2003; Barros-Battesti et al. 2003). On the other hand, several other tick records on birds in Brazil have referred to subadult stages of *Amblyomma* spp. (Aragão 1918, 1936; Marini et al. 1996; Rojas et al. 1999; Evans et al. 2000; Arzua et al. 2003; Labruna et al. 2004).

Ecological studies with subadult stages of *Amblyomma* spp. in Brazil have been affected by the fact that larvae or nymphs of several *Amblyomma* species are morphologically very similar or are still undescribed. For example, an extensive study conducted in the state of Paraná collected 129 ticks from 54 birds (mostly Passeriformes). The vast majority of these ticks (121 larval specimens) belonged to the genus *Amblyomma*, and therefore, they could not be identified further than the genus level (Marini et al. 1996). Another study in the state of Minas Gerais reported 177 *Amblyomma cajennense* larvae and nymphs from 70 Passeriformes birds (Rojas et al. 1999). As these authors reported that these ticks were identified by using a genus-level criterion for larvae (Clifford and Anastos 1960) and by comparison with the morphological description of the *A. cajennense* larva (Famadas et al. 1997), their procedure for taxonomic identification of the ticks (especially the nymphs) was definitely not convincing and must be reviewed.

Currently, subadult specimens of most of the 33 *Amblyomma* species established in Brazil can be identified to the species level by only two procedures: (i) rearing the subadult specimen until the adult stage and then identifying the species of the adult tick; (ii) use of molecular tools. By using the first procedure, several reports of *Amblyomma longirostre*, *Amblyomma pseudoconcolor*, *Amblyomma tigrinum*, and *Amblyomma dubitatum* have been reported in birds in Brazil (Aragão 1936; Evans et al. 2000; Labruna et al. 2004). By using the later procedure, larvae and nymphs of *A. aureolatum* were reported in several Passeriforme birds from the state of Paraná, by comparing 12S rRNA mitochondrial gene-partial sequences of *A. aureolatum* adult ticks with sequences generated from the subadult ticks (Arzua et al. 2003).

The present study reports a collection of *Amblyomma* spp. ticks in birds (mostly Passeriformes) from several areas of the state of São Paulo in Brazil. Using the procedure of rearing subadult ticks to the adult stage, at least four *Amblyomma* species were identified.

Materials and methods

Ticks were collected from naturally infested birds, captured by mist nets during different surveys in the following areas and year periods in the state of São Paulo: Taubaté (23°01' S, 45°33' W) from 1997 to 2000, Mogi das Cruzes (23°31' S, 46°10' W) during 2000, Piraju (23°11' S, 49°23' W) during 2004, and Guarujá (23°59' S, 45°15' W) during 2005. Bird surveys were conducted by independent research groups, which provided data for only tick-infested birds. For this reason, this is a descriptive study reporting ticks infesting birds, with no data about tick prevalence on the bird populations.

Ticks collected on the animals were immediately placed in dry plastic vials containing several fresh grass leaves, and covered by a cork containing several minute holes. Vials were properly identified and held under room temperatures for few days or weeks, and then sent to the laboratory. The purpose of this procedure was to try to maintain ticks alive inside the vials until arriving at the laboratory. Engorged larvae or nymphs that arrived alive at the laboratory were immediately placed in an incubator at 25°C and RH 90%, to allow them to molt to nymphs and adults, respectively. Nymphs obtained from the engorged larvae were allowed to feed on naive rabbits according to Pinter et al. (2002). Flat or partially engorged larvae and nymphs collected from birds were also allowed to feed on naive rabbits in order to try to complete their engorgement and thereafter, try to rear them to the adult stage. Each adult specimen obtained from an engorged nymph was used for identification of the species of the former corresponding subadult tick (larva or nymph) collected on the bird.

Additionally, unpublished records of ticks collected on birds and reared to the adult stage in the laboratory were obtained from the tick collection “Coleção Nacional de Carrapatos” (CNC) of the Faculty of Veterinary Medicine of the University of São Paulo. These records were from the following locations (one infested bird per location) from the state of São Paulo: Mogi das Cruzes, Piraju, Jundiaí (23°10' S, 46°52' W), Franca (20°32' S, 47°24' W), and Miracatu (24°17' S, 47°27' W).

Results

A total of 568 tick specimens (404 larvae, 164 nymphs) were collected from 261 bird specimens. From these ticks, 204 (36%) specimens (94 larvae, 110 nymphs) were reared to the

adult stage, being identified as *A. longirostre* (94 larvae, 90 nymphs), *Amblyomma calcaratum* (13 nymphs), *Amblyomma nodosum* (2 nymphs), and *A. cajennense* (5 nymphs). Additionally, 39 larvae reared to the nymphal stage and 8 nymphs that died before reaching the adult stage were identified as *A. longirostre* according to peculiar characters inherent to the nymphal stage of this species: scutum elongate, and hypostome pointed (Keirans and Durden 1998). These peculiar characters of the *A. longirostre* nymph were confirmed in the above mentioned *A. longirostre* subadults that were reared to the adult stage. The remaining 271 larvae and 46 nymphs died before reaching the adult stage or if reached the nymphal stage, they had hypostome rounded apically (common to the nymphs of other *Amblyomma* species) therefore; they were regarded as *Amblyomma* sp.

Ticks were collected from 51 species of birds distributed in 22 bird families and 6 orders (Tables 1 and 2). The order Passeriformes constituted the vast majority of the records, comprising 253 (97%) out of the 261 infested birds. Subadults of *A. longirostre* were identified from 35 species of Passeriformes, comprising 11 families (Cardinalidae, Dendrocolaptidae, Fringillidae, Furnariidae, Parulidae, Pipridae, Thamnophilidae, Thraupidae, Turdidae, Tyrannidae, and Vireonidae), and from 1 species of a non-passerine bird, a puffbird (Bucconidae). Subadults of *A. calcaratum* were identified from 5 species of Passeriformes, comprising 5 families (Cardinalinae, Conopophagidae, Pipridae, Thamnophilidae and Turdidae). Subadults of *A. nodosum* were identified from 2 species of Passeriformes, comprising two bird families (Thamnophilidae and Pipridae). Subadults of *A. cajennense* were identified from 2 species of non-passerine birds, belonging to 2 different orders (Ciconiiformes: Threskiornithidae, and Gruiformes: Cariamidae).

Birds were usually infested by low number of ticks. Overall, a total of 261 birds were infested by 568 ticks, giving a mean infestation of 2.2 ticks per bird (range: 1–16). Only 17 (7%) birds were infested by more than 5 ticks whereas 145 (56%) birds were infested by a single tick specimen.

Voucher specimens of ticks collected in the present study have been deposited in the CNC tick collection (accession numbers: 65–68, 84–87, 135, 136, 139–141, 146, 154, 158, 188, 196, 219, 220, 228, 232, 280, 290, 294, 317, 318, 331, 687, 726, 729, 788, 842–846, 857, 867, 907, 908, 913, 926).

Discussion

The present study reports four *Amblyomma* species parasitizing birds in the state of São Paulo. Bird parasitism was restricted to larvae or nymphs; no adult tick was found in birds during this study. Although we do not present data on prevalence of ticks on birds, our data include all birds that were found infested by ticks during the field works of Taubaté, Piraju, Guarujá, and Mogi das Cruzes. Thus, *A. longirostre* was far the most common tick species parasitizing passerine birds in these four areas. In Taubaté and Piraju, only 3 bird species were found infested by *A. calcaratum* in each locality, whereas only 2 bird species were found infested by *A. nodosum* in Guarujá, and no other tick species was found in Mogi das Cruzes. Possibly, the nymphs identified as *Amblyomma* sp. in birds from Taubaté, Piraju, and Guarujá (Table 1) belong to *A. nodosum* or *A. calcaratum*, although these nymphs died before molting and could not be identified to the species level.

Amblyomma longirostre is a Neotropical tick with established populations from Panama to southern Brazil and Argentina (Jones et al. 1972; Guimaraes et al. 2001). The adult stage feeds primarily on porcupines (*Coendou* spp.), whereas the immature stages seem to feed primarily on passerine birds (Aragão 1936; Jones et al. 1972). Although there have been

Table 1 Ticks collected from Passeriformes birds in the state of São Paulo

Bird family	Bird species (number of infested birds)	Locality	Number of ticks		<i>A. longirostre</i>		<i>A. nodosum</i>		<i>A. calcaratum</i>		<i>Amblyomma</i> sp.	
					Larvae	Nymphs	Nymphs	Nymphs	Nymphs	Larvae	Nymphs	
			Larvae	Nymphs								
Cardinalidae	<i>Saltator similis</i> (10)	Taubaté	4	11					1			
Conopophagidae	<i>Conopophaga lineata</i> (4)	Taubaté						1				4
Conopophagidae	<i>Conopophaga melanops</i> (6)	Taubaté						1				3
Dendrocolaptidae	<i>Campylorhamphus falcularius</i> (1) ^a	Taubaté	1									7
Dendrocolaptidae	<i>Lepidocolaptes squamatus</i> (1) ^a	Taubaté	1									1
Dendrocolaptidae	<i>Sittasomus griseicapillus</i> (1)	Taubaté		1								
Emberizidae	<i>Arremon flavivestris</i> (1)	Taubaté										1
Furnariidae	<i>Anabazenops fuscus</i> (1) ^a	Taubaté	1									
Furnariidae	<i>Automolus leucophthalmus</i> (8) ^a	Taubaté	13	1								1
Furnariidae	<i>Philydor rufum</i> (1) ^a	Taubaté		1								
Furnariidae	<i>Synallaxis ruficapilla</i> (2) ^a	Taubaté		1								1
Parulidae	<i>Basileuterus culicivorus</i> (9)	Taubaté	4	1								7
Pipridae	<i>Chiroxiphia caudata</i> (8)	Taubaté	10	1								11
Pipridae	<i>Iticura militaris</i> (5) ^a	Taubaté	1	1								6
Pipridae	<i>Manacus manacus</i> (18)	Taubaté	5	4								24
Thamnophilidae	<i>Dysithamnus mentalis</i> (4)	Taubaté										19
Thamnophilidae	<i>Thamnophilus caerulescens</i> (2) ^a	Taubaté		2								
Thraupidae	<i>Habia rubica</i> (4)	Taubaté	1	1								2
Thraupidae	<i>Tachyphonus coronatus</i> (7)	Taubaté	6	4								6
Thraupidae	<i>Trichothraupis melanops</i> (9)	Taubaté	5	2								21
Turdidae	<i>Turdus albicollis</i> (5)	Taubaté		3					3			1
Turdidae	<i>Turdus rufiventris</i> (2)	Taubaté		1								3
Tyrannidae	<i>Hemiriccus nidipendulus</i> (2) ^a	Taubaté		2								
Tyrannidae	<i>Mionectes rufiventris</i> (3)	Taubaté										3
Tyrannidae	<i>Myiopagis viridicata</i> (1) ^a	Taubaté	1									1
Tyrannidae	<i>Myiophobus fasciatus</i> (1) ^a	Taubaté	1									
Tyrannidae	<i>Platyrinchus mystaceus</i> (15) ^a	Taubaté	8	3								12
Vireonidae	<i>Cyclarhis guianensis</i> (1) ^a	Taubaté		1								

Table 1 continued

Bird family	Bird species (number of infested birds)	Locality	Number of ticks			
			<i>A. longirostre</i>			<i>Amblyomma</i> sp.
			Larvae	Nymphs	Nymphs	
Conopophagidae	<i>Conopophaga melanops</i> (1)	Guarujá	1			
Dendrocolaptidae	<i>Dendrocincla tyrannina</i> (2)	Guarujá	5			
Dendrocolaptidae	<i>Xiphorhynchus fuscus</i> (2)	Guarujá	3			
Thamnophilidae	<i>Dysithamnus mentalis</i> (3) ^a	Guarujá		2	1	
Furnariidae	<i>Xenops minutus</i> (1)	Guarujá		1		
Pipridae	<i>Chiroxiptia caudata</i> (3)	Guarujá		1		
Pipridae	<i>Manacus manacus</i> (35)	Guarujá	11	20	1	
Fringillidae	<i>Euphonia pectoralis</i> (2)	Guarujá	1	1		
Thraupidae	<i>Dacnis cayana</i> (1) ^a	Guarujá		1		
Thraupidae	<i>Ramphocelus bresilius</i> (10) ^a	Guarujá	15	12		
Thraupidae	<i>Tachyphonus coronatus</i> (2)	Guarujá		1		
Thraupidae	<i>Tachyphonus cristatus</i> (1) ^a	Guarujá		1		
Thraupidae	<i>Tangara seledon</i> (3)	Guarujá		1		
Tityridae	<i>Schiffornis virescens</i> (1)	Guarujá		1		
Troglodytidae	<i>Thryothorus longirostris</i> (2)	Guarujá		1		
Tyrannidae	<i>Artita rufus</i> (1) ^a	Guarujá		1		
Tyrannidae	<i>Leptopogon amaurocephalus</i> (1) ^a	Guarujá	1			
Tyrannidae	<i>Mionectes rufiventris</i> (1)	Guarujá	1			
Tyrannidae	<i>Phylloscartes ventralis</i> (1)	Guarujá		1		
Cardinalidae	<i>Salpator similis</i> (1)	Piraju		1		
Conopophagidae	<i>Conopophaga lineata</i> (5)	Piraju			6	
Dendrocolaptidae	<i>Xiphorhynchus fuscus</i> (1) ^a	Piraju	2			
Fringillidae	<i>Euphonia pectoralis</i> (1)	Piraju		1		
Furnariidae	<i>Automolus leucophthalmus</i> (4)	Piraju	2	1		
Pipridae	<i>Chiroxiptia caudata</i> (4)	Piraju	7			
Thamnophilidae	<i>Pyrglena leucoptera</i> (1)	Piraju			1	
Thamnophilidae	<i>Thamnophilus caerulescens</i> (1)	Piraju		2		
Thraupidae	<i>Habia rubica</i> (2)	Piraju		1		

Table 1 continued

Bird family	Bird species (number of infested birds)	Locality	Number of ticks						
			<i>A. longirostre</i>		<i>A. calcaratum</i>		<i>Amblyomma</i> sp.		
			Larvae	Nymphs	Nymphs	Nymphs	Larvae	Nymphs	
Thraupidae	<i>Tachyphonus coronatus</i> (4)	Piraju		2					
Thraupidae	<i>Tangara seledon</i> (1)	Piraju		1			3		1
Thraupidae	<i>Thraupis sayaca</i> (2) ^a	Piraju	1				3		
Thraupidae	<i>Trichothraupis melanops</i> (2)	Piraju	1	4			1		
Turdidae	<i>Turdus albicollis</i> (2)	Piraju					4		1
Turdidae	<i>Turdus fumigatus</i> (1) ^a	Piraju		1					
Dendrocolaptidae	<i>Sittasomus griseicapillus</i> (1)	M. Cruzes	1						
Dendrocolaptidae	<i>Xiphorhynchus fuscus</i> (1)	M. Cruzes	1				1		
Pipridae	<i>Chiroxiphia caudata</i> (1)	M. Cruzes	1				2		
Thamnophilidae	<i>Dysithamnus mentalis</i> (1)	M. Cruzes	1						
Thraupidae	<i>Tachyphonus coronatus</i> (4)	M. Cruzes	10	1			14		
Thraupidae	<i>Trichothraupis melanops</i> (2)	M. Cruzes	2				1		
Tityridae	<i>Schiffornis virescens</i> (2)	M. Cruzes					4		
Turdidae	<i>Turdus rufiventris</i> (1)	M. Cruzes					2		
Tyrannidae	<i>Mionectes rufiventris</i> (1)	M. Cruzes					1		
Tyrannidae	<i>Platyrinchus mystaceus</i> (1)	M. Cruzes	1						
Thraupidae	<i>Tangara seledon</i> (1)	Miracatu		1					
Total	253		121	96	2	13	255		45

^a Reported to be infested by *A. longirostre* for the first time

Table 2 Ticks collected from non-Passeriformes birds in the state of São Paulo

Bird order	Bird family	Bird species (number of infested birds)	Locality	Ticks			
				<i>A. longirostre</i>		<i>A. cajennense</i>	
				Larvae	Nymphs	Nymphs	Larvae
Apodiformes	Trochilidae	<i>Thalurania glaucopsis</i> (1)	Taubaté				4
Ciconiiformes	Threskiornithidae	<i>Theristicus caudatus</i> (1)	Franca		4		
Columbiformes	Columbidae	<i>Patagioenas cayanaensis</i> (1)	Piraju				1
Gruiformes	Cariamidae	<i>Cariama cristata</i> (1)	Jundiá		1		
Piciformes	Bucconidae	<i>Malacoptila striata</i> (1) ^a	Taubaté	2			
Piciformes	Bucconidae	<i>Malacoptila striata</i> (1)	M. Cruzes	12			3
Piciformes	Picidae	<i>Picumnus cirrattus</i> (1)	Taubaté				4
Piciformes	Ramphastidae	<i>Selenidera maculirostris</i> (1)	Guarujá				5
Total		8		12	2	5	16

^a Reported to be infested by *A. longirostre* for the first time

several reports of *A. longirostre* on migratory birds in North America (Jones et al. 1972; Scott et al. 2001), apparently this tick never became established in North America, what is probably related to two major facts: (i) adverse environmental conditions for the tick; (ii) absence of the primary host (*Coendou* spp.) for adult ticks. In fact, all four localities where birds were collected in the present study were naturally inhabited by porcupines (data not shown). Bird species previously reported infested by immature of *A. longirostre* are listed in Table 3. Based on these previous records, the present study reports 23 bird species infested by *A. longirostre* for the first time (Tables 1 and 2). Currently, 82 bird species are known to be infested by immature stages of *A. longirostre*, with the vast majority [74 (90%)] being Passeriformes. At least 60 of these bird species, including those found more times parasitized by *A. longirostre* in the present study (*Automolus leucophthalmus*, *Chiroxiphia caudata*, *Manacus manacus*, *Tachyphonus coronatus*, *Trichotrhaupis melanops*, *Platyrinchus mystaceus*, *Ramphocelus bresilius*, and *Saltator similis*), are mostly understorey birds, which nest in trees and rarely visit the ground (Sick 1997) (Table 3). Since porcupines *Coendou* spp. (primary hosts for the adult stage of *A. longirostre*) are typically arboreal and rarely visit the ground (Emmons and Feer 1997), the present records of *A. longirostre* immature ticks, mostly on arboreal birds, suggest that *A. longirostre* is an arboreal tick species, using the tree canopy for the free-living developmental stages.

Adult ticks of both *A. calcaratum* and *A. nodosum* have been reported almost exclusively on anteaters (*Tamandua tetradactyla* and *Myrmecophaga tridactyla*) (Aragão 1936; Fairchild et al. 1966; Jones et al. 1972), which are indeed primary hosts for the adult stage of these tick species. In fact, during the field work in Guarujá, two southern tamandua anteaters (*T. tetradactyla*) were found infested by ticks; one was infested by 22 adults of *A. nodosum* (15 males, 7 females) and 2 adults of *A. calcaratum* (1 male, 1 female) on 13 August 2006, and the other was infested by 20 adults of *A. nodosum* (7 males, 13 females) and 1 adult of *A. calcaratum* (1 female) on 31 August 2006 (unpublished data from the CNC tick collection, accession numbers 916, 920). To our knowledge, previous records for immature stages of *A. calcaratum* and *A. nodosum* on birds are restricted to the work of Jones et al. (1972), who cited “birds” without species designation. The present study provides the parasitism of *A. calcaratum* nymphs on *S. similis*, *Conopophaga lineata*, *Turdus albicollis*, *C. caudata*, and *Pyriglena leucoptera*; and the parasitism of *A. nodosum* nymphs on *Dysithamnus mentalis*, and *M. manacus*. Most of these species are understorey passerine birds, which usually visit the ground to seek for food (Sick 1997). For instance, *C. lineata*, the species more times parasitized by *A. calcaratum* nymphs in Piraju, as well as *T. albicollis* and *P. leucoptera*, are found close or on the ground most of time, where they look for insects (Ridgely and Tudor 1994; Sick 1997). These facts suggest that larvae and nymphs of both *A. calcaratum* and *A. nodosum* host seek on the ground surface. In fact, the giant anteater (*M. tridactyla*) is exclusively terrestrial (Emmons and Feer 1997), enabling larvae derived from engorged females to host seek on the ground. On the other hand, most passerine birds build their nests on trees usually 4–5 m above the ground (Ridgely and Tudor 1994; Sick 1997), where it could also be in contact with arboreal ticks, such as proposed here for *A. longirostre*. This might explain records of both *A. longirostre* and *A. calcaratum* or *A. nodosum* on the same bird species (e.g. *S. similis*, *T. albicollis*, *D. mentalis*, *M. manacus*, *C. caudata*) (Table 1), which have their nests on trees and live in the understorey and near the ground. Similarly, a few ground-feeding birds previously reported infested by *A. longirostre* build their nests on trees (Table 3), enabling them to get infested by arboreal ticks.

The present study provides two records of *A. cajennense* on two different bird species, *Theristicus caudatus* (Buff-necked Ibis) and *Cariama cristata* (Red-legged Seriema).

Table 3 Literature reports of parasitism of *Amblyomma longirostre* larvae and/or nymphs on birds in the Americas

Bird order	Bird family	Bird species	Bird habits ^a	Nest location ^a	Reference
Passeriformes	Cardinalidae	<i>Saltator similis</i>	Arboreal	Tree	Arzua et al. (2005)
Passeriformes	Cardinalinae	<i>Saltator maximus</i>	Mostly terrestrial	Tree	Aragão (1936)
Passeriformes	Conopophagidae	<i>Conopophaga lineata</i>	Mostly terrestrial	Ground	Arzua et al. (2005)
Passeriformes	Dendrocolaptidae	<i>Dendrocincla turdina</i>	Arboreal	Tree	Arzua et al. (2005)
Passeriformes	Dendrocolaptidae	<i>Lepidocolaptes souleyetii</i>	Arboreal	Tree	Arnold (1970)
Passeriformes	Dendrocolaptidae	<i>Sittasomus griseicapillus</i>	Arboreal	Tree	Arzua et al. (2005)
Passeriformes	Dendrocolaptidae	<i>Xiphorhynchus guttatus</i>	Arboreal	Tree	Arnold (1970)
Passeriformes	Emberizidae	<i>Cyanococcyzops cyanooides</i>	Arboreal	Tree	Arnold (1970)
Passeriformes	Thamnophilidae	<i>MacKenzieana severa</i>	Mostly arboreal	Tree	Arzua et al. (2005)
Passeriformes	Parulidae	<i>Wilsonia canadensis</i>	Arboreal	Tree	Scott et al. (2001)
Passeriformes	Furnariidae	<i>Automolus ochrolaemus</i>	Mostly arboreal	Ground	Arnold (1970)
Passeriformes	Furnariidae	<i>Philydor atricapillus</i>	Arboreal	Tree	Arzua et al. (2005)
Passeriformes	Furnariidae	<i>Synallaxis spixi</i>	Arboreal	Tree	Arzua et al. (2005)
Passeriformes	Furnariidae	<i>Syndactyla rufosuperciliata</i>	Arboreal	Tree	Venzal et al. (2005)
Passeriformes	Icteridae	<i>Cacicus cela</i>	Arboreal	Tree	Aragão (1936)
Passeriformes	Icteridae	<i>Icterus jamacaii</i>	Arboreal	Tree	Aragão (1936)
Passeriformes	Parulidae	<i>Basileuterus culicivorus</i>	Arboreal	Tree	Arzua et al. (2005)
Passeriformes	Pipridae	<i>Chiroxiphia caudata</i>	Mostly arboreal	Tree	Arzua et al. (2005)
Passeriformes	Pipridae	<i>Chiroxiphia linearis</i>	Mostly arboreal	Tree	Arnold (1970)
Passeriformes	Pipridae	<i>Manacus manacus</i>	Mostly arboreal	Tree	Arzua et al. (2005)
Passeriformes	Thamnophilidae	<i>Cercomacra tyrannina</i>	Arboreal	Tree	Arnold (1970)
Passeriformes	Thamnophilidae	<i>Euphonia pectoralis</i>	Arboreal	Tree	Arzua et al. (2005)
Passeriformes	Thamnophilidae	<i>Euphonia violacea</i>	Arboreal	Tree	Arzua et al. (2005)
Passeriformes	Thamnophilidae	<i>Taraba major</i>	Mostly arboreal	Tree	Arnold (1970)
Passeriformes	Thamnophilidae	<i>Thamnophilus bridgesi</i>	Mostly arboreal	Tree	Arnold (1970)
Passeriformes	Thraupidae	<i>Habia rubica</i>	Arboreal	Tree	Arzua et al. (2005)
Passeriformes	Thraupidae	<i>Cyanococcyzops brissonii</i>	Mostly arboreal	Tree	Arzua et al. (2005)
Passeriformes	Thraupidae	<i>Phlogothraupis sanguinolenta</i>	Arboreal	Tree	Hoffmann (1962)
Passeriformes	Thraupidae	<i>Pipraeidea melanota</i>	Arboreal	Tree	Arzua et al. (2005)
Passeriformes	Thraupidae	<i>Tachyphonus coronatus</i>	Arboreal	Tree	Arzua et al. (2005)
Passeriformes	Thraupidae	<i>Tangara seledon</i>	Arboreal	Tree	Arzua et al. (2005)

Table 3 continued

Bird order	Bird family	Bird species	Bird habits ^a	Nest location ^a	Reference
Passeriformes	Thraupidae	<i>Tangara</i> sp.	Arboreal	Tree	Arnold (1970)
Passeriformes	Thraupidae	<i>Tersina viridis</i>	Arboreal	Tree	Arzua et al. (2005)
Passeriformes	Thraupidae	<i>Trichothraupis melanops</i>	Arboreal	Tree	Arzua et al. (2005)
Passeriformes	Troglodytidae	<i>Thryothorus atrogularis</i>	Arboreal	Tree	Arnold (1970)
Passeriformes	Troglodytidae	<i>Thryothorus longirostris</i>	Arboreal	Tree	Arzua et al. (2005)
Passeriformes	Troglodytidae	<i>Thryothorus modestus</i>	Arboreal	Tree	Arnold (1970)
Passeriformes	Troglodytidae	<i>Thryothorus nigricapillus</i>	Mostly arboreal	Tree	Arnold (1970)
Passeriformes	Turdidae	<i>Turdus amaurochalinus</i>	Mostly arboreal	Tree	Arzua et al. (2005)
Passeriformes	Turdidae	<i>Turdus rufiventris</i>	Mostly terrestrial	Tree	Arzua et al. (2005)
Passeriformes	Turdidae	<i>Turdus subalaris</i>	Mostly terrestrial	Tree	Arzua et al. (2005)
Passeriformes	Turdidae	<i>Turdus albicollis</i>	Mostly terrestrial	Tree	Venzal et al. (2005)
Passeriformes	Turdidae	<i>Turdus</i> sp.	Mostly arboreal	Tree	Aragão (1936)
Passeriformes	Unidentified	“gobe-mouche”			Neumann (1899)
Passeriformes	Unidentified	“ <i>Muscicapa</i> sp.”			Morel (1967)
Passeriformes	Tyrannidae	<i>Elaenia parvirostris</i>	Arboreal	Tree	Venzal et al. (2005)
Passeriformes	Tyrannidae	<i>Empidonax traillii</i>	Arboreal	Tree	Scott et al. (2001)
Passeriformes	Tyrannidae	<i>Lathrotriccus euleri</i>	Arboreal	Tree	Arzua et al. (2005)
Passeriformes	Tyrannidae	<i>Mionectes oleagineus</i>	Arboreal	Tree	Arnold (1970)
Passeriformes	Tyrannidae	<i>Mionectes rufiventris</i>	Arboreal	Tree	Arzua et al. (2005)
Passeriformes	Tyrannidae	<i>Myiarchus ferox</i>	Arboreal	Tree	Arzua et al. (2005)
Passeriformes	Tyrannidae	<i>Myiodynastes maculatus</i>	Arboreal	Tree	Arzua et al. (2005)
Passeriformes	Tyrannidae	<i>Phylloscartes ventralis</i>	Arboreal	Tree	Arzua et al. (2005)
Passeriformes	Tyrannidae	<i>Rhynchocycclus brevirostris</i>	Arboreal	Tree	Hoffmann (1962)
Passeriformes	Tyrannidae	<i>Tolmomyias sulphurescens</i>	Arboreal	Tree	Hoffmann (1962)
Passeriformes	Tyrannidae	<i>Tolmomyias sulphurescens</i>	Arboreal	Tree	Arzua et al. (2005)
Passeriformes	Vireonidae	<i>Vireo olivaceus</i>	Arboreal	Tree	Scott et al. (2001)

Table 3 continued

Bird order	Bird family	Bird species	Bird habits ^a	Nest location ^a	Reference
Coraciiformes	Momotidae	<i>Baryphthengus ruficapillus</i>	Arboreal	Ground	Arzua et al. (2005)
Coraciiformes	Momotidae	<i>Baryphthengus ruficapillus</i>	Arboreal	Ground	Arnold (1970)
Cuculiformes	Cuculidae	<i>Crotophaga</i> sp.	Mostly terrestrial	Ground	Aragão (1936)
Galliformes	Cracidae	<i>Penelope obscura</i>	Arboreal	Tree	Arzua et al. (2005)
Galliformes	Cracidae	<i>Penelope</i> sp.	Arboreal	Tree	Aragão (1936)
Gruiformes	Rallidae	<i>Laterallus albigularis</i>	Terrestrial	Ground	Arnold (1970)
Piciformes	Picidae	<i>Celeus flavescens</i>	Arboreal	Tree	Arzua et al. (2005)
Piciformes	Ramphastidae	<i>Ramphastos dicolorus</i>	Arboreal	Tree	Keirans (1985)
Strigiformes	Strigidae	<i>Pulsatrix koenigswaldiana</i>	Arboreal	Tree	Arzua et al. (2005)

Additional data on bird habits and nest location are provided according to current literature

^a According to Ridgely and Tudor (1994) and Sick (1997)

Despite of several previous records of *A. cajennense* immature ticks on birds (Fairchild et al. 1966; Rojas et al. 1999; Estrada-Pena et al. 2004; Arzua et al. 2005), these records require further evaluation since larvae and nymphs were not identified by currently reliable methods for this species (i.e. rearing ticks to the adult stage, or by molecular methods). *A. cajennense* is one of the most abundant tick species in Latin America, where it has shown a broad host range for all parasitic stages (Estrada-Pena et al. 2004). However, its host range has been almost restricted to medium- to large-sized mammals. Interestingly, the two records reported in the present study refer to medium-sized birds of two different orders, with habits predominantly terrestrial, although both species build large, massive nests in tall trees (Sick 1997).

Although life-histories of most of the Neotropical *Amblyomma* species are poorly known, especially when considering subadult stages, it seems that passerine birds act as primary hosts for larvae and nymphs of at least four species: *A. aureolatum* (Arzua et al. 2003), *A. longirostre*, *A. calcaratum*, and *A. nodosum*. Other Neotropical *Amblyomma* species, such as *Amblyomma tigrinum* (Evans et al. 2000; Gonzalez-Acuna et al. 2004; Nava et al. 2006) and *Amblyomma pseudoconcolor* (Aragão 1936) might also use birds as primary hosts for immature stages. Finally, studies on ticks infesting birds have important implications on the geographical distribution of ticks and tick-borne pathogens, since migrating birds have been implicated in transportation of infected ticks through lands and abroad continents (Hoogstraal 1961; Bjoersdorff et al. 2001).

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