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Bird ticks in an area of the Cerrado of Minas Gerais State, southeast Brazil

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Abstract In the present study the tick prevalence, mean intensity of infestation and species were recorded on birds captured between January 2009 and December 2010 in the Ecological Station Pirapitinga-ESEC from Minas Gerais State, Brazil. A total of 967 birds, from 15 families and 40 species were captured and 165 (17.1 %) individuals were parasitized by ticks. Of these 160 (97 %) belonged to the order Passeriformes. Five tick species were identified: *Amblyomma longirostre* ($n = 274$) was the most common species followed by *Amblyomma parvum* ($n = 43$), *Amblyomma nodosum* ($n = 39$), *Amblyomma ovale* ($n = 24$) and *Riphicephalus sanguineus* ($n = 7$). None of 61 unengorged larvae molted to nymph. The mean intensity of infestation was 2.7 ± 2.4 ticks per bird (448 ticks/165 birds) ranging from 1 to 10. Only 19 (11.4 %) birds were infested with one species of tick. The remaining birds were infested by two, three or four species of ticks. Also new hosts for all five ticks were recorded. Only nymphs were recorded throughout the year with two similar peaks during autumn and winter 2009 and 2010.

Keywords Ticks · Birds · *Amblyomma* spp. · Nymph · Survey · Brazil

Introduction

The emergence or reemergence of diseases transmitted by ticks is a matter of global concern. Several species of birds act as hosts for one or more stages of ticks and may spread ticks and pathogens to various parts of the world (Ogrzewalska et al. 2008, 2009a, b, 2011; Ioannou et al. 2009; Jordan et al. 2009).

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Information on the occurrence of ticks on birds in Brazil is still scarce when considering the huge Brazilian territory and several biomes of the country. For instance, the following papers refer to work done in the south and southeast states, particularly in areas of Atlantic Forest (Barros-Battesti et al. 2003; Labruna et al. 2007; Soares et al. 2008; Ogrzewalska et al. 2008, 2009a, 2011), and in the cerrado (Rojas et al.1999; Szabó et al. 2008; Tolesano-Pascoli et al. 2010). Thus, it is very important to pay special attention to this issue because of the great diversity of birds and their associated tick species expected to occur in Brazil. This paper is part of a long-term research project designed to investigate the diversity of ticks in southeast Brazil.

Materials and methods

Bird capture occurred between January 2009 and December 2010 in the Ecological Station Pirapitinga-ESEC, located at an island of the water reservoir of Hydroelectric Power Plant Três Marias, State of Minas Gerais, (18° 20′S and 45° 17′W). The Ecological Station has an area of approximately 1,000 ha. The level of the dam oscillates 559 and 568 m above sea level.

All captures of birds were performed monthly by using 10–16 mist nets of 2 × 12 m, arranged in linear transects, totaling 100–188 m of nets in the studied site.

The ticks were removed manually and/or with tweezers and kept in labeled bottles containing 70 % alcohol for identification. Engorged larvae and nymphs were taken alive to the laboratory of Ixodologia at Federal Rural University of Rio de Janeiro and kept at 27 ± 1 °C and 80 ± 5 % RH to allow ecdyses for nymphs and adults, respectively. The identification of the unengorged nymphs was based on Martins et al. (2010) and the identification of adults was based on Barros-Battesti et al. (2006) both with the aid of a stereoscopic microscope. Unengorged larvae were identified to genus level due to absence of specific key.

Prevalence of infestation (PI), the ratio between the number of birds infested and number of birds examined multiplied by 100, and the tick mean intensity of infestation (TMI), the number of ticks collected, divided by the total number of infested birds were calculated as before (Bush et al. 1997).

Data was analyzed to determine whether tick prevalence from every season of 2009 differed from those recorded in 2010 and if it presented a seasonal variation during the 2 years of study. The larval and adult ticks were excluded from analysis because they were recorded in low numbers. Prevalence rates were analyzed by the chi-square test at a significance level of 5 %.

All collections were made with permission of the Brazilian Institute of Natural Resources (IBAMA), according to the protocol 16753-1/2009. Voucher specimens were deposited in the tick collection of the Instituto Butantan, Sao Paulo, SP, Brazil. Accession numbers: *A. parvum*—2 nymphs (IBSP 10844), *A. ovale*—1 nymph (IBSP 10845), *A. longirostre*—2 nymphs (IBSP 10846), *A. nodosum*—2 nymphs (IBSP 10847), *A. cajennense*—male and female (IBSP 10848) and *Rhipicephalus sanguineus*—2 females (IBSP10849).

Results

Overall 967 birds from 15 families and belonging to 40 species were examined and 165 (17.1 %) were infested by ticks. Of these, 160 (97 %) belonged to the order Passeriformes

(Table 1). We collected 448 ticks (5 adults, 382 nymphs and 61 larvae) overwhelmingly from the genus *Amblyomma* but *Rhipicephalus* as well. Ticks collected in the adult stage were identified as *A. longirostre* ($n = 3$), *A. nodosum* ($n = 1$) and *A. ovale* ($n = 1$). Of the 382 nymphs collected, only 168 (44 %) molted to the adult stage in the laboratory. However, all collected ticks in the nymphal stage were identified at specific level. *Amblyomma longirostre* ($n = 271$) was the most common species followed by *A. parvum* ($n = 43$), *A. nodosum* ($n = 38$), *A. ovale* ($n = 23$) (Table 1) and *R. sanguineus* ($n = 7$) (Table 1 footnote). None of unengorged larvae molted to nymph after being fed on domestic rabbits (*Oryctolagus cuniculus*), an experimental host commonly used for infestation with neotropical species of *Amblyomma* (Faccini et al. 2010). Thus, 61 larvae were identified only to genus level as *Amblyomma* sp. The three adults (two males and one female) of *A. longirostre* were collected from three different birds species of two orders (Passeriformes and Caprimulgiformes) and three families (Thamnophilidae, Caprimulgidae and Tyrannidae). Nymphs of *A. longirostre* were identified in 30 species in four orders (Passeriformes, Caprimulgiformes, Apodiformes and Columbiformes) and 11 families (Thamnophilidae, Tyrannidae, Furnariidae, Rynchocyclidae, Corvidae, Turdidae, Thraupidae, Emberezidade, Caprimulgidae, Columbidae and Trochilidae). Nymphs of *A. parvum* were identified on nine bird species from two orders (Passeriformes and Columbiformes) and five families (Tyrannidae, Rynchocyclidae, Thraupidae, Emberezidade and Columbidae).

The female of *A. nodosum* was collected on *Turdus amaurochalinus*, family Turdidae, while the nymphs were identified on 12 bird species from the order Passeriformes and eight families (Thamnophilidae, Tyrannidae, Rynchocyclidae, Tytiridae, Turdidae, Thraupidae, Emberezidade and Parulidae).

The male of *A. ovale* was identified in *Sporophila nigricollis*, family Emberezidae, while the nymphs were identified in five species in the order Passeriformes and four families (Tyrannidae, Troglodytidae, Turdidae, Emberezidade).

Nymphs of *R. sanguineus* were identified in only one species, *Gnorimopsar chopi*, order Passeriformes and family Icteridae.

The mean intensity of tick infestation was 2.7 ± 2.4 ticks per bird (448 ticks/165 birds) ranging from 1 to 10 ticks per bird. Only 19 (11.4 %) birds were infested with one species of tick. The remaining birds were infested by two, three or four species of ticks (Table 2).

There was no statistical difference between tick prevalence of the four seasons of 2009 when compared with those recorded in 2010 ($p > 0.05$). However when the data of each season in both years were pooled, there was no statistical difference between the prevalence found in winter (25.5 %) and autumn (18.5 %), and between spring (6.5 %) and summer (5.3 %) ($p > 0.05$) but the prevalence of the first two seasons were statistically different from the prevalence of the last two seasons ($p < 0.05$). Thus, the seasonal pattern seen in Fig. 1 displays a higher prevalence in the autumn and winter and a decrease in spring and summer.

Discussion

Four species of *Amblyomma* and *R. sanguineus* were found in birds in this study. In Brazil, the larval and nymphal stages of *Amblyomma* are commonly found parasitizing birds, especially the nymphal stage (Barros-Battesti et al. 2006; Ogrzewalska et al. 2008, 2009a, b, 2011). These records follow, in general, the pattern of parasitism in birds in both tropical and temperate regions of the world. Adult ticks of three species of ticks were recorded

Table 1 Ticks collected on birds in the Ecological Station of Pirapitinga—ESEC, Minas Gerais

No. birds examined/birds infested	Number of ticks*												
	A. longirostre			*A. nodosum*			*A. parvum*			*A. ovale*			*Amblyomma* sp.
	LL	NN	AA	LL	NN	AA	LL	NN	AA	LL	NN	AA	LL
Passeriformes													
Thamnophilidae													
Thamnophilus caerulescens (2/1)		5	1M										
T. torquatus (1/1)[d]					1								2
Formicivora melanogaster (1/1)[a]		2											1
Furnariidae													
Certhiaxis cinnamomeus (10/1)[a]		1											
Tyrannidae													
Elaenia mesoleuca (35/3)[a]		7			1								
Elaenia cristata (23/3)[a,d]		6	1M		2								2
Elaenia flavogaster (45/2)[a]		3											2
T. melancholicus (14/2)[a,c]		9									2		
T. savana (11/2)[a,b]		15						5					1
Pitangus sulphuratus (24/1)[b]								7					
C. rufus (60/2)[a,b,d]		6			1			2					1
Myiozetetes similis (32/3)[a]		3											
M. ferox (45/7)[c]											9		
Myiarchus tuberculifer (5/1)[a]		3											
Lathrotriccus euleri (52/11)		12											3
X. velatus (17/2)[a,b]		3						1					1
X. cinereus (27/5)[a]		6											4
Rynchocyclidae													
H. margaritaceiventer (37/5)[a]		6			1								1

Table 1 continued

No. birds examined/birds infested	Number of ticks*												
	A. longirostre			*A. nodosum*			*A. parvum*			*A. ovale*			*Amblyomma* sp.
	LL	NN	AA	LL	NN	AA	LL	NN	AA	LL	NN	AA	LL
Tityridae													
P. polychopterus (14/1)					1								
Corvidae													
Cyanocorax cristatellus (45/6)[a]		20											15
Troglodytidae													
T. musculus (15/6)[c]											7		
Turdidae													
Turdus rufiventris (34/11)		34									2		
T. amaurochalinus (51/14)		26			12	1F							
Thraupidae													
Nemosia pileata (24/3)[a]		5											
Tangara cayana (12/2)[a]		7											
R. carbo (49/21)[a,b,d]		42			6			11					15
Saltator similis (33/3)					4								
Dacnis cayana (25/5)[b]		10						6					2
Tangara palmarum (24/6)[a]		19											
Emberizidae													
Sporophila lineola (20/2)[a]		2											
S. nigricollis (21/7)[a,b]		6						4			3	1M	
S. caerulescens (17/3)[a,b,d]		2			1			4					1
S. leucoptera (3/3)[a]		7											
Parulidae													
B. culicivorus (23/4)					5								

Table 1 continued

No. birds examined/birds infested	Number of ticks*												
	A. longirostre			*A. nodosum*			*A. parvum*			*A. ovale*			*Amblyomma* sp.
	LL	NN	AA	LL	NN	AA	LL	NN	AA	LL	NN	AA	LL
B. flaveolus (26/3)					3								
Non passeriformes													
Caprimulgidae													
H. albicollis (2/1)[a]		1	1F										
Columbidae													
Leptotila verreauxi (17/1)								3					
Leptotila rufaxilla (6/1)[a]		1											4
Trochildae													
E. macroura (13/2)		2											6

LL larvae, *NN* nymphs, *AA* adults

New records for [a]*A. longirostre,* [b]*A. parvum,* [c]*A. ovale,* [d]*A. nodosum*

* In addition, 7 nymphs of *Rhipicephalus sanguineus* were found on 52 examined individuals of *Gnorimopsar chopi* (Passeriformes, Icteridae) (new record)

Table 2 Prevalence and tick mean intensity (TMI) of infestation collected on birds in The Ecological Station of Piraptinga—ESEC, Minas Gerais

Order	Family (*n*)	Species	Birds examined/ infested/ticks	Prevalence (%)	TMI
Passeriformes	Thamnophilidae (3)	*Thamnophilus caerulencens*	2/1/6	50	6
		T. torquatus	1/1/3	100	3
		Formicivora melanogaster	1/1/3	100	3
	Furnariidae (1)	*Certhiaxis cinnamomeus*	10/1/3	10	1.5
	Tyrannidae (9)	*E. mesoleuca*	35/3/8	8.6	2.7
		E. cristata	23/3/11	13	3.7
		E. flavogaster	45/2/5	4.4	2.5
		T. melancholicus	14/2/11	14.3	5.5
		T. savana	11/2/21	18.2	10.5
		P. sulphuratus	24/1/7	4.2	7
		C. rufus	60/2/10	3.3	5
		Myiozetetes similis	32/3/3	9.4	1
		M. ferox	45/7/9	15.6	1.3
	Rynchocyclidae (5)	*H. margaritaceiventer*	37/5/8	13.5	1.6
		L. euleri	52/11/15	21.2	1.4
		M. tuberculifer	5/1/3	20	3
		X. velatus	17/2/5	11.8	2.5
		X. cinereus	27/5/10	18.5	2.0
	Tityridae (1)	*P. polychopterus*	14/1/1	7.1	1
	Corvidae (1)	*C. cristatellus*	45/6/35	13.3	5.8
	Troglodytidae (1)	*T. musculus*	15/6/7	40	1.2
	Turdidae (2)	*T. rufiventris*	34/11/36	32.4	3.3
		T. amaurochalinus	51/14/39	27.5	2.8
	Thraupidae (6)	*N. pileata*	24/3/5	12.5	1.7
		T. cayana	12/2/7	16.7	3.5
		R. carbo	49/21/74	42.9	3.5
		S. similis	33/3/4	9.1	1.3
		D. cayana	25/5/8	20	1.6
		T. palmarum	24/6/19	25	3.2
	Emberizidae (4)	*S. lineola*	20/2/2	10	1
		S. nigricollis	21/7/14	33.3	2
		S. caerulescens	17/3/8	17.6	2.7
		S. leucoptera	3/3/7	100	2.3
	Parulidae (2)	*B. culicivorus*	23/4/5	17.4	1.3
		B. flaveolus	26/3/3	11.5	1
	Icteridae (1)	*G. chopi*	52/7/7	13.5	1
Caprimulgiformes	Caprimulgidae (1)	*H. albicollis*	2/1/2	50	2
Columbiformes	Columbidae (2)	*L. verreauxi*	17/1/3	5.9	3
		L. rufaxilla	6/1/5	16.7	5
Apodiformes	Trochildae (1)	*E. macroura*	13/2/8	15.4	4

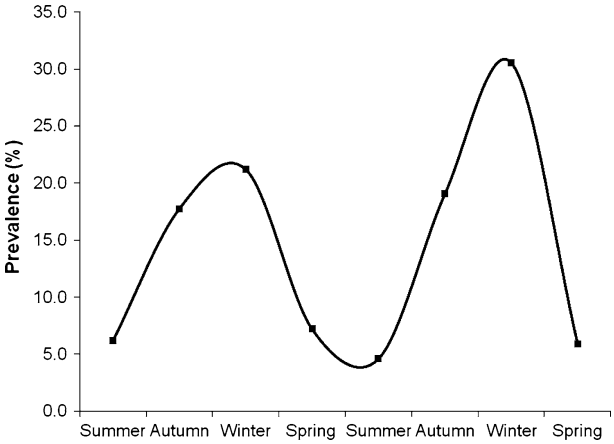

Fig. 1 Seasonal prevalence of tick nymphs on birds captured in the Ecological Station Pirapitinga—ESEC, Minas Gerais state (MG), Brazil, 2009–2010

parasitizing birds: *A. longirostre* ($n = 3$), *A. nodosum* ($n = 1$) and *A. ovale* ($n = 1$). This type of association is probably not the rule because recent studies published by Labruna et al. (2007) and Ogrzewalska et al. (2008, 2009a, 2011) mention the absence of adult ticks parasitizing birds in different Atlantic forest areas in the State of São Paulo.

Amblyomma longirostre was the most common tick species parasitizing passerine and non-passerines birds in the present study. Immatures of this tick are also common in birds captured in the Atlantic forest biome, southeast Brazil (Labruna et al. 2007; Ogrzewalska et al. (2008, 2009a, 2011) and in the Cerrado (savannah) biome, northeast Brazil (Tolesano-Pascoli et al. 2010). Although, this tick parasitizes mainly passerines (Barros-Battesti et al. 2006), the occurrence of this species in Neotropical non-passerine birds was also reported by (Arzúa et al. 2005; Labruna et al. 2007; Ogrzewalska et al. 2009a). Adults of this species parasitize chiefly mammals of the order Rodentia (Barros-Battesti et al. 2006; Nava et al. 2010).

In this paper, *A. longirostre* was recorded from 25 species of birds for the first time (Table 1). Of these, 11 belonged to Tyrannidae family, allowing us to infer that this bird family is important for the life-cycle of *A. longirostre* at the site of the survey. Parasitism of *Hydropsalis albicollis* (Caprimulgidae) by one nymph and one female of *A. longirostre* was unexpected. *H. albicollis* is a bird that lives on forest litter and nests on the ground. Labruna et al. (2007) suggested that *A. longirostre* is an arboreal tick since the free-living stages search porcupines (*Coendou* spp.), primary hosts for the adult stage and arboreal birds, hosts for immatures, in the canopy. Thus, we believe that the *H. albicollis* parasitism might have occurred by chance.

The second most common species parasitizing birds at the Ecological Station ESEC-Pirapitinga was *A. parvum*. This species has been recorded on birds, mammals (wild and domestic) and even man (Martins et al. 2004; Guglielmone et al. 2006) in Brazil. There are records in the Amazon, Cerrado (savannah) and Pantanal biomes (Mullins et al. 2004; Szabo et al. 2007; Cançado et al. 2008). Its primary host in Brazil is still unknown (Labruna et al. 2005; Szabo et al. 2007). In Argentina, the primary hosts of immatures is the rodent *Galea musteloides* (Nava et al. 2008), but these authors pointed out that populations of *A. parvum* from Argentina and Brazil might be different species. It is worth noting the isolation of rickettsia group of Brazilian Spotted Fever (BSF) from *A. parvum* by Pacheco et al. (2007) as an important warning sign about the possibility of this species of tick also be a vector of spotted fever rickettsiosis for humans.

Amblyomma nodosum was the third most frequently found species studied. This species has previously been recorded in both passerine and non-passerines birds (Ogrzewalska et al. 2009a; Tolesano-Pascoli et al. 2010). In our study none of non-passerine birds captured were parasitized by *A. nodosum*. Among passerine birds, 12 species were parasitized by *A. nodosum*. Among the species parasitized by *A. nodosum*, nine have preference for lower strata *Thamnophilus torquatus*, *Hemitriccus margaritaceiventer*, *Pachyramphus polychopterus*, *T. amaurochalinus*, *Ramphocelus carbo*, *Sporophila caerulescens*, *Basileuterus culicivorus*, *Basileuterus flaveolus* and *Casiornis rufus* (Ferreira et al. 2010). The species most infested with *A. nodosum* was *R. carbo,* a species which forages both the canopy and the understory (Sick 1997). Larvae and nymphs of *A. nodosum* appear to have preference for birds that visit strata near the ground (Labruna et al. 2007). Probably birds foraging on the ground or very close to the soil stratum are important in maintaining the life cycle of *A. nodosum* on the studied area as already pointed out by Ogrzewalska et al. (2009a) and Tolesano-Pascoli et al. (2010). The adults of this species are commonly found in the anteaters *Myrmecophaga tridactyla* and *Tamandua* spp. (Labruna et al. 2007; Tolesano-Pascoli et al. 2010). It is worth mentioning that *Rickettsia parkeri* was recently isolated from *A. nodosum* parasitizing birds in Brazil (Ogrzewalska et al. 2009a).

Amblyomma ovale is the fourth species most commonly found in this study. This species is commonly found associated with various orders of mammals (Labruna et al. 2005). Ogrzewalska et al. (2009b, 2011) recorded for the first time *A.ovale* parasitizing birds of the families Thamnophilidae, Turdidae and Emberezidae. In the present study, we recorded for the first time *A. ovale* in the families Tyrannidae (*Tyrannus melancholicus* and *Myiarchus ferox*) and Troglodytidae (*Troglodytes musculus*) (Table 1). Three species of migratory birds were recorded as parasitized by this tick: *Tyrannus savana*, *Xolmis velatus* and *Xolmis cinereus* (Table 1). *T. savana* is a migratory species from the southern region of Brazil, which migrates to reproduce in the central region of Brazil during spring and summer (Marini et al. 2009; Ferreira et al. 2010). *X. velatus* is common in the Cerrado especially in the spring and summer (Sick 1997; Ferreira et al. 2010) as migrants from the Amazon and central Brazil. Their range goes from the mouth of the Amazon River to states of Santa Catarina and Mato Grosso, and to Bolivia and Paraguay as well (Sick 1997). *X. cinereus*, popularly known as "spring", is seen mainly in the southeast during the spring and summer (Sick 1997; Ferreira et al. 2010). Reports of parasitism by ticks on migratory birds and their likely association with various types of pathogens have already been mentioned in various regions of the world (Scott et al. 2001; Hildebrandt et al. 2010). Thus, these records call attention to the importance of studies of parasitism by ticks on migratory birds in Brazil, their migration routes and transported pathogens.

Finally, the species *R. sanguineus* was collected in seven (13.5 %) of 52 individuals of the species *G. chopi* examined. Each one was parasitized by an engorged nymph, identified after molting to females. During a visit to a rural area near the site of collection of ticks, we observed a group of 15 *G. chopi* feeding on the ground next to dogs regardless of possible attacks from them. Probably, this would be an opportunity for the attachment of nymphs of *R. sanguineus.* Although the dog is the primary hosts of *R. sanguineus* in Brazil, the species has been found in wildlife (Labruna et al. 2005; Szabó et al. 2008; Tolesano-Pascoli et al. 2010). In addition, it is well known the ease with which colonies of *R. sanguineus* can be maintained in the laboratory, using naïve domestic rabbits as experimental hosts (Piranda et al. 2008). Therefore, the data published here, along with those reported in the literature, suggest a certain ability of Brazilian populations of *R. sanguineus* to adapt to other hosts than dogs. It is notorious that the patterns of tick

specificity can be changed with the extension of tick range or introduction of host species physiologically acceptable into the tick environment (Faccini and Barros-Battesti 2006).

During visits to the study site we randomly collected from the vegetation and in our team members 42 ticks (19 females, 7 males and 16 nymphs), all identified as *A. cajennense*. However, none of the captured birds was found parasitized by this tick. Studies in the Atlantic Forest (Labruna et al. 2007; Ogrzewalska et al. 2009a, 2011) and the Cerrado (Tolesano-Pascoli et al. 2010) recorded a low prevalence of *A. cajennense* parasitizing birds, which corroborates our results. The presence of *A. cajennense* can be explained by the presence of various mammals in the study area and its surroundings, mainly large populations of horses and capybaras, primarily hosts for *A. cajennense*. These hosts and other wild mammals probably were able to maintain the population of *A. cajennense* with no need of alternative hosts as birds. Regarding the seasonality of ticks parasitizing birds, we found that nymphs were recorded throughout the year with two similar peaks for 2009 and 2010, during autumn and winter, suggesting that these seasons are the most appropriate for *Amblyomma* nymphs found on birds at the study site.

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