Revista Brasileira de Parasitologia Veterinária
ISSN: 0103-846X
zacariascbpv@fcav.unesp.br
Colégio Brasileiro de Parasitologia Veterinária
Brasil

Alves Costa Santolin, Ísis Daniele; Ribeiro Luz, Hermes; Alchorne, Nívea Maria; da Costa Pinheiro, Michele; Melinski, Ramiro Dário; Faccini, João Luiz Horácio; Ferreira, Ildemar; Famadas, Kátia Maria

Ticks on birds caught on the campus of the Federal Rural University of Rio de Janeiro, Brazil

Revista Brasileira de Parasitologia Veterinária, vol. 21, núm. 3, julio-septiembre, 2012, pp. 213-218
Colégio Brasileiro de Parasitologia Veterinária
Jaboticabal, Brasil

Full Article

Rev. Bras. Parasitol. Vet., Jaboticabal, v. 21, n. 3, p. 213-218, jul.-set. 2012
ISSN 0103-846X (impresso) / ISSN 1984-2961 (eletrônico)

Ticks on birds caught on the campus of the Federal Rural University of Rio de Janeiro, Brazil

Carrapatos em aves capturadas no campus da Universidade Federal Rural do Rio de Janeiro, Brasil

Ísis Daniele Alves Costa Santolin[1]*; Hermes Ribeiro Luz[1]; Nívea Maria Alchorne[2]; Michele da Costa Pinheiro[1]; Ramiro Dário Melinski[2]; João Luiz Horácio Faccini[1]; Ildemar Ferreira[2]; Kátia Maria Famadas[1]

[1]Laboratório de Ixodologia, Departamento de Parasitologia Animal, Instituto de Veterinária - IV, Universidade Federal Rural do Rio de Janeiro – UFRRJ, Seropédica, RJ, Brasil

[2]Laboratório de Ornitologia, Departamento de Biologia Animal, Instituto de Biologia – IB, Universidade Federal Rural do Rio de Janeiro – UFRRJ, Seropédica, RJ, Brasil

Received September 22, 2011
Accepted March 21, 2012

Abstract

The prevalence of parasitic infections, particularly those caused by ectoparasites, may influence the biology and ecology of wild birds. The aim of this study was to investigate occurrences and identify the species of ticks collected from wild birds caught on the campus of the Federal Rural University of Rio de Janeiro. The birds were caught using mist nets between October 2009 and December 2010. In total, 223 birds were caught, represented by 53 species and 19 families in nine orders. Nineteen birds (n = 7 species) were parasitized by immature ticks (prevalence of 8.5%). Forty-four ticks were collected, of which 23 were nymphs and 21 were larvae. There were associations between parasitism by ticks and non-Passeriformes birds, and between parasitism and ground-dwelling birds, which was possibly due to the presence (or inclusion among the captured birds) of *Vanellus chilensis* (Charadriiformes: Charadriidae). All the nymphs collected were identified as *Amblyomma cajennense.* In general terms, we must emphasize that wild birds in the study area may play the role of dispersers for the immature stages of *A. cajennense*, albeit non-preferentially.

Keywords: Bird, tick, *Amblyomma cajennense,* ecology.

Resumo

A prevalência das infecções parasitárias e em particular, aquelas causadas por ectoparasitos, pode influenciar na biologia e ecologia das aves silvestres. O objetivo do estudo foi investigar a ocorrência e identificar as espécies de carrapatos coletadas em aves silvestres capturadas no campus da Universidade Federal Rural do Rio de Janeiro. As aves foram coletadas em rede-de-neblina durante o período de outubro de 2009 a dezembro de 2010. No total foram capturadas 223 aves representadas por 53 espécies, 19 famílias em 9 ordens. Parasitismo por formas imaturas de carrapatos, foram encontradas em 19 aves (n = 7 espécies) correspondendo a uma prevalência de 8,5%. Foram coletados 44 carrapatos onde 23 estavam em estágio de ninfa e 21 em estágio de larva. Houve associação entre o parasitismo por carrapatos e aves não Passeriformes e entre o parasitismo e aves de hábitos terrestres capturadas, que se deu possivelmente pela presença (ou inclusão da captura) de *Vanellus chilensis* (Charadriiforme: Charadriidae). Todas as ninfas coletadas foram identificadas como *Amblyomma cajennense*. De modo geral, devemos ressaltar que aves silvestres da área estudada podem exercer papel de dispersoras, ainda que não preferenciais, para estágios imaturos de *A. cajennense.*

Palavras-chave: Ave, carrapato, *Amblyomma cajennense,* ecologia.

Introduction

Ectoparasitism occurs widely across the globe, affecting different groups of organisms at a variety of levels (CLAYTON et al., 2004). Among the organisms affected, birds are considered to be the hosts for various species including mites, ticks, lice and dipteran insects (CLAYTON; JOHNSON, 2003; LYRA-NEVES et al., 2003; CLAYTON et al., 2004; HIGGINS et al., 2005; STORNI et al., 2005). Ticks are vectors for many pathogenic agents, both for domestic and wild animals and for humans. Because of their low mobility, ticks depend on hosts for their dispersal (TOLESANO-PASCOLI et al., 2010). Many bird species have been reported to be their hosts, not only during the larval and nymph stages (BARROS-BATTESTI et al. 2006), but also during the adult stage (JORDAN et al., 2009; TOLESANO-PASCOLI et al., 2010; COSTA, 2011).

*Corresponding author: Ísis Daniele Alves Costa Santolin
Laboratório de Ixodologia, Departamento de Parasitologia Animal, Instituto de Veterinária – IV, Universidade Federal Rural do Rio de Janeiro – UFRR, BR-465, Km 07, CEP 23890-000, Seropédica, RJ, Brasil
e-mail: isis@santolin.com.br

Few published papers have addressed parasitism of ticks on wild birds. The recent studies by Labruna et al. (2007), Ogrzewalska et al. (2009, 2010) and Tolesano-Pascoli et al. (2010) in Brazil, as well as those carried out by Graham et al. (2010) and Jordan et al. (2009) can be highlighted. As stated by Ogrzewalska et al. (2009), studies on species of ticks carried by wild birds in different ecosystems may help towards understanding their dispersion as possible vectors for disease transmission. Thus, the objective of the present study was to identify the tick species that infested wild birds that are present on the campus of the Federal Rural University of Rio de Janeiro, in the municipality of Seropédica, state of Rio de Janeiro, in remnant fragments of the Atlantic Forest biome, which might provide complementary information for mapping the tick species that infest these animals.

Materials and Methods

The Federal Rural University of Rio de Janeiro (UFRRJ) (22° 48' 27" S and 43° 37' 17" W) is located in the municipality of Seropédica, state of Rio de Janeiro, at km 7 of the BR-465 highway, and covers an area of approximately 3,024 hectares. The region presents typical Atlantic Forest vegetation, with forest fragments, but a large proportion is characterized as presenting secondary vegetation with large areas of cleared fields and pasture as consequence of urbanization (FERREIRA et al., 2010) (Figure 1).

The birds used in the present study were caught on 10 mist nets of dimensions 12 × 2.5 m and mesh size of 36 × 36 mm, which were positioned linearly. Bird-catching was performed monthly between morning and twilight from October 2009 to December 2010. The birds were identified and classified in accordance with Sigrist (2007) and CBRO (2009). Ticks were removed manually and/or using tweezers and were taken to the laboratory in order to perform taxonomic identification procedures. After checking each bird's body and removing the ticks, the birds were released into the environment. The ticks collected during the nymph stage were identified by means of the dichotomous key of Martins et al. (2010), and then were stored in flasks containing alcohol (70GL). Some of the larvae that were collected were placed on domestic rabbits, as an experimental infestation, in order to complete the tick lifecycle, as described by Pinter et al. (2002). The larvae that were not fixed on domestic rabbits were put in a B.O.D. heated chamber at a temperature of 27 ± 1 °C and relative humidity of 80 ± 5% in order to allow ecdysis to occur. If they still did not complete their lifecycles, they were stored in flasks containing alcohol (70GL) and were identified at genus level by means of the identification key proposed by Clifford and Anastos (1960).

All samples were gathered with permission from IBAMA, in accordance with procedural no. 16753-1/2009. The experimental infestations were performed with authorization from the Ethics Committee of UFRRJ under protocol no. 010016/2010. The ticks collected in the present study will be deposited in the Tick Collection of the Butantan Institute (IBSP), São Paulo, state of São Paulo (curator: Dr. D. M. Barros-Battesti).

1. *Statistical analysis*

For the statistical analysis, the birds were grouped according to order (Passeriformes and Non-Passeriformes), habitat (canopy, undergrowth, field or ground-dwelling) and trophic guild (insectivorous, frugivorous, granivorous, necrophagous, nectarivorous or omnivorous). The chi-square (χ^2) test was used for the order variable, while Fisher's test was used for the habitat and trophic guild variables. Both tests were performed with a significance level of 5%. These tests were performed in order to ascertain whether the observed distribution of ectoparasitism frequencies diverged significantly from the expected frequencies, using the R statistical package (R DEVELOPMENT CORE TEAM, 2009).

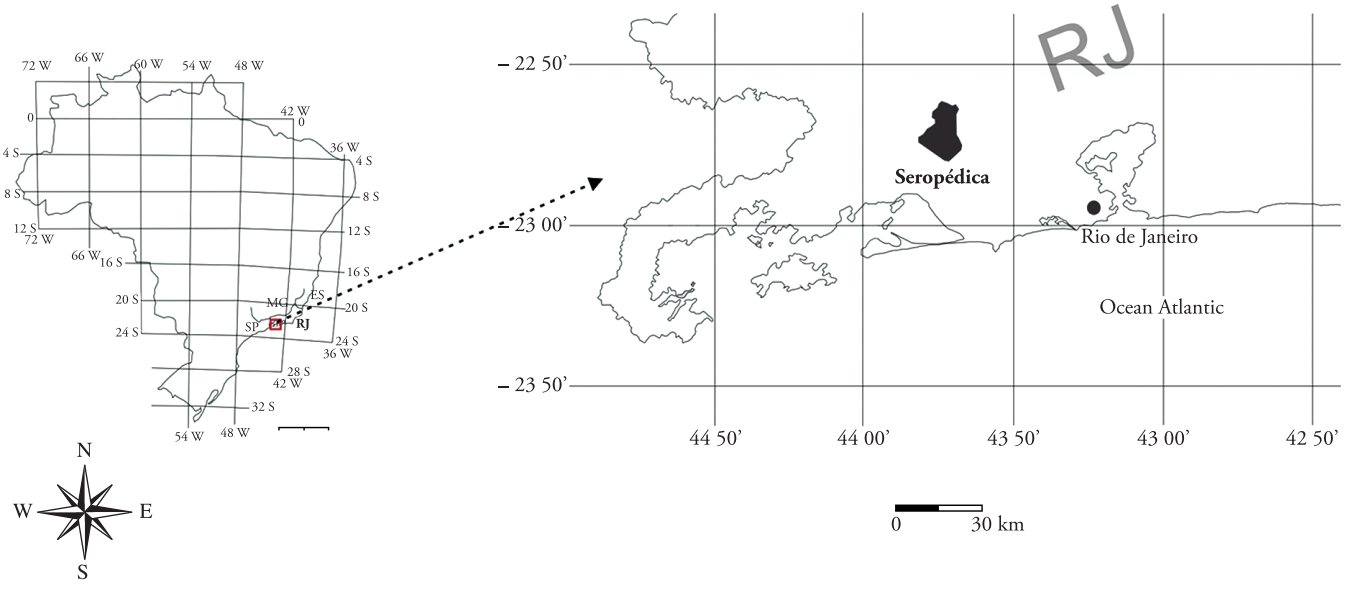

Figure 1. Location of the study area. Federal Rural University of Rio de Janeiro, Seropédica - RJ.

Results

In total, 44 ticks (23 nymphs and 21 larvae) were collected from the 223 birds caught. All the nymphs collected were identified as *Amblyomma cajennense* (Fabricius, 1787). After ecdysis of three larvae (14%) to the nymph stage had occurred, these specimens were also identified as *A. cajennense*. The remaining 18 larvae (86%) were identified as *Amblyomma* spp. Out of the total number of birds, 19 specimens distributed in seven species were infested by ticks, which corresponded to a total prevalence of 8.5% and mean intensity of 1.0 tick per bird (Table 1). The Passeriformes order presented the highest number of infested species: *Turdus amaurochalinus* (n = 4), *Sporophila leucoptera* (n = 1), *Volatinia jacarina* (n = 1), *Pitangus sulphuratus* (n = 1) and *Ramphocelus bresilius* (n = 1). Columbiformes was the least representative order, with only 1 infested species, *Columbina talpacoti* (n = 1). *Vanellus chilensis*, which belongs to the Charadriiformes order, was the species with the greatest prevalence of parasitism, with 66% (n = 10 individuals). The analysis on associations with parasitism shown by the order (Passeriformes versus non-Passeriformes), and in relation to the habitat and the trophic guild, was performed using the chi-square test. The variables of the order (Passeriformes versus non-Passeriformes) and the habitat occupied by the bird ($p = 0.001$ and $p = 0.0000008$ for $p < 0.05$, respectively) presented associations, thus showing that the probability of infestation by ticks on birds was greater among non-Passeriformes birds and ground-dwelling birds. For the variables of trophic guild and parasitism, no association was observed ($p = 0.6731$ for $p > 0.05$) (Table 2).

Discussion

Only nymph and larval stages were found on the birds on the UFRRJ campus. Both of these stages are commonly found infesting birds (BARROS-BATTESTI et al., 2006). The absence of adult ticks infesting birds was also mentioned by Labruna et al. (2007) and Ogrzewalska et al. (2009) after studying birds in Atlantic Forest areas in the state of São Paulo.

Vanellus chilensis was the bird species that presented the greatest number of infested individuals. This species is common on the UFRRJ campus, where they forage and nest on the ground (FERREIRA et al., 2010), and it is this ground-dwelling behavior that favors parasitism (ARZUA et al., 2003). Another important factor favoring this parasitism that should be mentioned is that this bird species lives in areas commonly frequented by horses and capybaras.

The species with the second greatest number of infested individuals was *T. amaurochalinus*, which some authors have reported in association with ticks (ARZUA et al., 2005; PEREZ et al., 2008). Larval and nymph parasitism in *Turdus* was reported in the states of Rio de Janeiro (STORNI et al., 2005) and Paraná (ARZUA, 2007). The presence of ticks among this group of birds is related to their foraging habit, which consists of hopping and turning leaves, often making holes in the ground with their beaks in searching for food (STORNI et al. 2005; WALDENSTRÖM et al., 2007).

The geographical distribution of the parasites coincided with the geographical distribution of the host fauna (KLOMPEN et al., 1996). Thus, the presence of *A. cajennense* on birds may be associated with the high degree of anthropization of the area, as well as the presence of horses and capybaras. The predominance of this ixodid on the campus is also corroborated by Silveira (2010), who correlated greater occurrence of *A. cajennense* on the UFRRJ campus with environments with high levels of anthropic activities and the presence of horses and capybaras. Previous reports also correlated the high degree of anthropization with the presence of this ixodid (LABRUNA et al., 2001; SZABÓ et al. 2009) because this species is less sensitive to changes in the ecological structure of the area, which relates mainly to the availability of wild hosts (CANÇADO et al., 2008). Rojas et al. (1999) also reported that *A. cajennense* was the dominant ixodid in captures performed in special protection areas in the *cerrado* (savanna-like terrain). However, comparisons between the results reported in their study and the results from the present study should be made carefully, since not only do the two areas present completely different phytophysiognomies, but also the methodology used by those authors for identifying ticks needs to be reviewed (LABRUNA et al., 2007). Other studies carried out in the *cerrado* have also reported low prevalence of immature stages of *A. cajennense* and greater occurrence of *Amblyomma longirostre* and *Amblyomma nodosum* (TOLESANO-PASCOLI et al., 2010).

A. cajennense is considered to be a generalist concerning host species, especially during the larval and nymph stages, since during these immature stages it does not have sufficient energy to use in searching for an ideal host, in comparison with adult ticks (RANDOLPH, 2004). Thus, they can use birds not only for feeding but also for dispersal. Considering that, in the area studied, there is frequent activity of horses and capybaras, which are preferred hosts of this ixodid, the possibility of occurrence of *A. cajennense* in other host species is reduced. This can be correlated with the low mean intensity of ticks associated with the birds found in the present study, which was close to the intensities reported by Ogrzewalska et al. (2009) from studying birds in the Atlantic Forest, and Tolesano-Pascoli et al. (2010) among birds in the *cerrado*. Their studies indicated that these birds could be used as alternative hosts for the immature stages of this species.

The statistical analysis showed that birds that live on the ground, especially non-Passeriformes birds, were more prone to parasitism by ticks in the area studied. This association was probably due to the presence (or inclusion among the birds caught) of *V. chilensis*. It should be highlighted that in most inventories involving parasitism among wild birds, there are reports of greater, and sometimes exclusive, parasitism of the order Passeriformes in areas with typical *cerrado* vegetation (PASCOAL, 2009; TOLESANO-PASCOLI et al., 2010) and typical areas of Atlantic Forest (LABRUNA et al., 2007; OGRZEWALSKA et al., 2009, 2010). This order has also been considered to be important for maintaining the lifecycle of ticks such as *A. nodosum*, playing the role of host for their immature stages (OGRZEWALSKA et al., 2009). However, none of the surveys involving non-Passeriformes birds have reported captures of *V. chilensis*. The result from the analysis between different trophic guilds corroborated the results of Marini et al. (1996), who reported a weak association between parasitism and trophic guilds.

Table 1. List of bird species captured in UFRRJ between October 2009 and December 2010, with their classification (order, family, trophic guild and habit), and the number (N) of infested birds in relation to the number (N) of birds caught. Indicative values of prevalence of infestation (PI) and mean infestation intensity (MII).

Order	Family	Species	N infested/ N captured	Trophic guild	Habit	PI (%)	MII	N ticks
Apodiformes								
	Trochilidae	*Eupetomena macroura*	0/2	Ne	Sg	0	-	0
Cathartiformes							-	
	Cathartidae	*Coragyps atratus*	0/2	N	Ca	0	-	0
Charadriiformes							-	
	Charadriidae	*Vanellus chilensis*	10/15	I	tr	66.7	1	10
Columbiformes							-	
	Columbidae	*Columbina minuta*	0/4	G	sg	0	-	0
		Columbina talpacoti	1/17	G	ru	5.9	1	1
		Leptotila verreauxi	0/4	G	tr	0	-	0
Cuculiformes							-	
	Cuculidae	*Tapera naevia*	0/1	I	sg	0	-	0
		Guira guira	0/1	I	ru	0	-	0
		Crotophaga ani	0/1	I	ru	0	-	0
		Coccyzus melacoryphus	0/2	I	sg	0	-	0
Passeriformes							-	
	Troglodytidae	*Cantorchilus longirostris*	0/1	O	sg	0	-	0
		Troglodytes musculus	0/1	I	sg	0	-	0
	Vireonidae	*Hylophilus thoracicus*	0/1	I	sg	0	-	0
	Dendrocolaptidae	*Lepidocolaptes angustirostris*	0/1	I	sg	0	-	0
	Emberizidae	*Emberizoides herbicola*	0/1	G	sg	0	-	0
		Sicalis flaveola	0/18	G	ru	0	-	0
		Sporophila caerulescens	0/4	G	ru	0	-	0
		Sporophila collaris	0/1	G	sg	0	-	0
		Sporophila leucoptera	1/7	G	ru	14.3	1	1
		Volatinia jacarina	1/2	G	ru	50	1	1
	Furnariidae	*Certhiaxis cinnamomeus*	0/1	I	ru	0	-	0
		Furnarius figulus	0/4	I	sg	0	-	0
		Furnarius rufus	0/6	I	ru	0	-	0
	Hirundinidae	*Pygochelidon cyanoleuca*	0/3	I	ru	0	-	0
		Stelgidopteryx ruficollis	0/2	I	ru	0	-	0
	Icteridae	*Molothrus bonariensis*	0/3	G	ru	0	-	0
	Passeridae	*Passer domesticus*	0/3	O	ru	0	-	0
	Thraupidae	*Ramphocelus bresilius*	1/6	F	sg	16.7	1	1
		Tangara cayana	0/1	F	ru	0	-	0
		Tangara palmarum	0/1	I	sg	0	-	0
		Tersina viridis	0/2	F	sg	0	-	0
		Thlypopsis sordida	0/2	O	sg	0	-	0
		Thraupis sayaca	0/15	F	sg	0	-	0
	Turdidae	*Turdus albicollis*	0/1	O	sg	0	-	0
		Turdus amaurochalinus	4/21	O	sg		1	4
		Turdus leucomelas	0/2	O	sg	0	-	0
		Turdus rufiventris	0/1	O	ru	0	-	0
	Tyrannidae	*Camptostoma obsoletum*	0/2	I	sg	0	-	0
		Elaenia flavogaster	0/24	I	sg	0	-	0
		Fluvico lanengeta	0/2	I	sg	0	-	0
		Megarynchus pitangua	0/2	I	sg	0	-	0
		Myiozetetes similis	0/5	I	sg	0	-	0
		Pitangus sulphuratus	1/10	I	ru	10	1	1
		Satrapa icterophrys	0/2	I	sg	0	-	0
		Tolmomyias sulphurescens	0/1	I	sg	0	-	0

Table 1. Continued...

Order	Family	Species	N infested/ N captured	Trophic guild	Habit	PI (%)	MII	N ticks
		Tyrannus albogularis	0/1	I	sg	0	-	0
		Tyrannus melancholicus	0/7	I	sg	0	-	0
Piciformes							-	
	Picidae	*Colaptes campestris*	0/1	I	tr	0	-	0
		Picumnus cirratus	0/4	I	sg	0	-	0
Psittaciformes								
	Psittacidae	*Aratinga leucophthalma*	0/1	F	ca	0	-	0
Strigiformes								
	Strigidae	*Megascops choliba*	0/1	I	sg	0	-	0
Total			**19/223**			**8.5**	**1**	**19**

Table 2. Number of individuals (% infested) caught at UFRRJ between October 2009 and December 2010, in relation to the variable of order, habitat and trophic guild.

Variables		Infested birds/ Examined birds	Prevalence of infestation (%)
Order	Passeriformes	8/168	4.7[a]
	Non-Passeriformes	11/56	19.6[b]
Habitat	Canopy	0/3	0[a]
	Undergrowth	5/122	4.1[a]
	Field	4/79	5.1[a]
	Ground-dwelling	10/20	50[b]
Trophic guild	Insectivorous	11/116	9,5[a]
	Granivorous	3/61	4,9[a]
	Necrophagous	0/2	0 [a]
	Nectarivorous	0/2	0 [a]
	Omnivorous	4/31	12.9 [a]
	Frugivorous	1/12	8.3 [a]

Note: Lower-case letters represent significance of association by means of the chi-square test (χ^2) for the order variable and by means of Fisher's test for the habitat and trophic guild variables, with 5% significance level.

Thus, it can be concluded that despite the low number of birds infested by *A. cajennense*, it is possible that the local avifauna plays an important role in the lifecycle of this ixodid, even in the presence of preferred hosts, such as horses and capybaras. In general terms, the fact that wild birds in the area studied may play the role of dispersers for immature stages of *A. cajennense*, even though not preferentially, should be highlighted.

References

Arzua M. *Diversidade de carrapatos (Acari: Ixodidae) de remanescentes de Floresta Estacional Semidecidual e de Floresta Ombrófila Densa, no Estado do Paraná* [Tese]. Curitiba: Universidade Federal do Paraná; 2007.

Arzua M, Onofrio VC, Barros-Battesti DM. Catalogue of the tick collection (Acari: Ixodida) of the Museu de História Natural Capão da Imbuia, Curitiba, Paraná, Brazil. *Rev Bras Zool* 2005; 22(3): 623-632. http://dx.doi.org/10.1590/S0101-81752005000300015

Arzua M, Silva MN, Famadas KM, Beati L, Barros-Battesti DM. *Amblyomma aureolatum* and *Ixodes auritulus* (Acari: Ixodidae) on birds in southern Brazil, with notes on their ecology. *Exp Appl Acarol* 2003; 31(3-4): 283-296. http://dx.doi.org/10.1023/B:APPA.0000010381.24903.1c

Barros-Battesti DM, Arzua M, Bechara GH. *Carrapatos de importância médico-veterinária da Região Neotropical*: Um guia ilustrado para identificação de espécies. São Paulo: Vox; ICTTD-3; Butantan; 2006.

Cançado PHD. *Carrapatos de animais silvestres e domésticos no Pantanal Sul- Mato-grossense (sub-região da Nhecolândia)*: espécies, hospedeiros e infestações em áreas com diferentes manejos [Tese]. Rio de Janeiro: Universidade Federal Rural do Rio de Janeiro; 2008.

Clayton DH, Bush SE, Johnson KP. Ecology of Congruence: Past Meets Present. *Syst Biol* 2004; 53(1): 165-173. http://dx.doi.org/10.1080/10635150490265102

Clayton DH, Johnson KP. Linking coevolutionary history to ecological process: Doves and lice. *Evolution* 2003; 57 (10): 2335-2341.

Clifford CM, Anastos G. The use of chaetotaxy in the identification of larval ticks (Acarina: Ixodidae). *J Parasitol* 1960; 46(5): 567-578. http://dx.doi.org/10.2307/3274939

Comitê Brasileiro de Registros Ornitológicos - CBRO. *Listas das aves do Brasil* [online]. 2009 [cited 2010 Nov 20]. Available from: http://www.cbro.org.br.

Costa ÍDA. *Fauna de carrapatos (Acari: Ixodidae) em aves silvestres no campus da Universidade Federal Rural do Rio de Janeiro, Seropédica e na Ilha de Itacuruçá, Mangaratiba, Rio de Janeiro* [Dissertação]. Rio de Janeiro: Universidade Federal Rural do Rio de Janeiro; 2011.

Ferreira I, Ventura PEC, Luz HR. *Aves no campus da Universidade Federal Rural do Rio de Janeiro*. Rio de Janeiro: Editora da Universidade Federal Rural do Rio de Janeiro; 2010.

Graham RI, Mainwaring MC, Du Feu R. Detection of spotted fever group *Rickettsia* spp. from bird ticks in the U.K. *Med Vet Entomol* 2010; 24(3): 340-343.

Higgins BF, Lopes LE, Santana FHA, Couri MS, Pujol-Luz JR. Sobre a ocorrência de *Philornis angustifrons* e *Philornis deceptiva* (DIPTERA, MUSCIDADE) em ninhos de *Suiriri affinis* e *Suiriri islerorum* (AVES, TYRANNIDAE) no Cerrado do Distrito Federal, Brasil. *Entomol vector* 2005; 12(1): 127-131.

Jordan BE, Onks KR, Hamilton SW, Hayslette SE, Wright SM. Detection of *Borrelia burgdorferi* and *Borrelia lonestari* in Birds in Tennessee. *J Med Entomol* 2009; 46(1):131-138. http://dx.doi.org/10.1603/033.046.0117

Klompen JSH, Black WC, Keirans JE, Oliver Junior JH. Evolution of ticks. *Annu Rev Entomol* 1996; 41:141-161. http://dx.doi.org/10.1146/annurev.en.41.010196.001041

Labruna MB, Sanfilippo LFS, Demetrio C, Menezes AC, Pinter A, Guglielmone AA, et al. Ticks collected on birds in the state of São Paulo, Brazil. *Exp Appl Acarol* 2007; 43: 147-160. http://dx.doi.org/10.1007/s10493-007-9106-x

Labruna MB, Kerber CE, Ferreira F, Faccini JLH, Waal DT, Gennari SM. Risk factors to tick infestations and their occurrence on horses in the state of São Paulo, Brazil. *Vet Parasitol* 2001; 97(1): 1-14. http://dx.doi.org/10.1016/S0304-4017(01)00387-9

Lyra-Neves RM, Farias ÂMI, Telino-Júnior WR. Ecological relationships between feather mites (Acari) and wild birds of Emberizidae (Aves) in a fragment of Atlantic Forest in northeastern Brazil. *Rev Bras de Zool* 2003; 20(3): 481-485. http://dx.doi.org/10.1590/S0101-81752003000300019

Marini MA, Reinert BL, Bornschein MR, Pinto JC, Pichorim MA. Ecological correlates of ectoparasitism on Atlantic Forest birds, Brazil. *Ararajuba* 1996; 4(2): 93-102.

Martins TF, Onofrio VC, Barros-Battesti DM, Labruna MB. Nymphs of the genus *Amblyomma* (Acari: Ixodidae) of Brazil: descriptions, redescriptions, and identification key. *Ticks Tick Borne Dis* 2010; 1(2): 75-99. http://dx.doi.org/10.1016/j.ttbdis.2010.03.002

Ogrzewalska M, Uezu A, Labruna MB. Ticks (Acari: Ixodidae) infesting wild birds in the eastern Amazon, northern Brazil, with notes on rickettsial infection in ticks. *Parasitol Res* 2010; 106(4): 809-816. http://dx.doi.org/10.1007/s00436-010-1733-1

Ogrzewalska M, Pacheco RC, Uezu A, Richtzenhain LJ, Ferreira F, Labruna MB. Ticks (Acari: Ixodidae) infesting birds in an Atlantic rain forest region of Brazil. *J Med Entomol* 2009; 46(5): 225-229. http://dx.doi.org/10.1603/033.046.0534

Pascoal JO. *Carrapatos em aves, no ambiente e em animais domésticos em área de cerrado do Triângulo Mineiro, Uberlândia, MG* [Dissertação]. Minas Gerais: Universidade Federal de Uberlândia; 2009.

Perez CA, Almeida AF, Almeida, A, Carvalho VHB, Balestrin DC, Guimarães MS, et al. Carrapatos do gênero *Amblyomma* (Acari: Ixodidae) e suas relações com os hospedeiros em área endêmica para febre maculosa no estado de São Paulo. *Rev Bras Parasitol Vet* 2008; 17(4):210-217.

Pinter A, Labruna MB, Faccini JL. The sex ratio of *Amblyomma cajennense* (Acari: Ixodidae) with notes on the male feeding period in the laboratory. *Vet Parasitol* 2002; 105(1): 79-88. http://dx.doi.org/10.1016/S0304-4017(01)00650-1

Randolph SE. Tick ecology: processes and patterns behind the epidemiological risk posed by ixodid ticks as vectors. *Parasitology* 2004; 129: 37-65. http://dx.doi.org/10.1017/S0031182004004925

R Development Core Team. *R*: A language and environment for statistical computing. Vienna: R Foundation for Statistical Computing; 2009.

Rojas R, Marini MA, Coutinho MTZ. Wild Birds as Hosts of *Amblyomma cajennense* (Fabricius, 1787) (Acari: Ixodidae). *Mem Inst Oswaldo Cruz* 1999; 94(3): 315-322. http://dx.doi.org/10.1590/S0074-02761999000300007

Sigrist T. *Guia de Campo Aves do Brasil Oriental*. Editora Avisbrasilis; 2007.

Silveira AK. *Caracterização de ecossistemas com potenciais de risco para a infestação por carrapatos e transmissão de riquétsias para humanos no estado do Rio de Janeiro* [Dissertação] Rio de Janeiro: Universidade Federal Rural do Rio de Janeiro; 2010.

Storni A, Alves MAS, Valim MP. Ácaros de penas e carrapatos (Acari) associados a *Turdus albicollis* Viellot (Aves, Muscicapidae) em uma área de Mata Atlântica da Ilha Grande, Rio de Janeiro, Brasil. *Rev Bras Zool* 2005; 22(2): 419-423. http://dx.doi.org/10.1590/S0101-81752005000200017

Szabó MPJ, Labruna MB, Garcia MV, Pinter A, Castagnolli KC, Pacheco RC, et al. Ecological aspects of the free-living ticks (Acari: Ixodidae) on animal trails within Atlantic rainforest in south-eastern Brazil. *Ann Trop Med Parasitol* 2009; 103(1): 57-72.

Tolesano-Pascoli GV, Torga K, Franchin AG, Ogrzewalska M, Gerardi M, Olegário MMM, et al. Ticks on birds in a forest fragment of Brazilian Cerrado (savanna) in the municipality of Uberlândia, State of Minas Gerais, Brazil. *Rev Bras Parasitol Vet* 2010; 19(4): 244-248. http://dx.doi.org/10.1590/S1984-29612010000400010

Waldenström J, Lundkvist A, Falk KI, Garpmo U, Bergström S, Lindegren G, et al. Migrating Birds and Tickborne Encephalitis Virus. *Emerg Infect Dis* 2007; 13(8): 1215-1218. http://dx.doi.org/10.3201/eid1308.061416