



Ticks of the genus *Amblyomma* (Acari: Ixodidae) on wild birds in the Brazilian Amazon

Authors: Martins, Thiago F., Fecchio, Alan, and Labruna, Marcelo B.

Source: Systematic and Applied Acarology, 19(4) : 385-392

Published By: Systematic and Applied Acarology Society

URL: <https://doi.org/10.11158/saa.19.4.1>

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

Ticks of the genus *Amblyomma* (Acari: Ixodidae) on wild birds in the Brazilian Amazon

THIAGO F. MARTINS¹, ALAN FECCHIO² & MARCELO B. LABRUNA¹

¹Departamento de Medicina Veterinária Preventiva e Saúde Animal, Faculdade de Medicina Veterinária e Zootecnia, Universidade de São Paulo, Av. Prof. Orlando Marques de Paiva, 87, CEP 05508-000, Cidade Universitária, São Paulo, SP, Brazil.

²Departamento de Biologia, Instituto de Ciências Biológicas, Universidade Federal do Amazonas, Av. Gal. Rodrigo Octávio Jordão Ramos, 3000, CEP 69077-000, Coroado I, Manaus, AM, Brazil
E-mail: labruna@usp.br

Abstract

The Amazon biome harbors the richest avifauna in the world. However, in the Brazilian Amazon only a single previous study has systematically evaluated wild birds for ticks. During 2012, wild birds were captured in two areas of the Brazilian Amazon forest, one located in the State of Amazonas, and another in the State of Pará. Overall, 581 wild birds representing 118 species were captured, but only 18 individuals (3.1% prevalence) were infested by ticks, comprising immature stages of *Amblyomma calcaratum* Neumann, 1899, *Amblyomma geayi* Neumann, 1899, *Amblyomma humerale* Koch, 1844, and *Amblyomma longirostre* (Koch, 1844). The only previous study of birds in the Brazilian Amazon reported 40.2% tick prevalence. Such contrasting prevalence values may stem from seasonal differences or differences in forest disturbance at the two sites.

Key words: Ticks, genus *Amblyomma*, wild birds, Brazilian Amazon

Introduction

The Amazon is the largest and most diverse of the world's tropical forests, covering more than 6.6 million km² in nine countries of South America (Mittermeier *et al.* 2003). Approximately two-thirds of the bird species reported from Brazil can be found in the Amazon (Silveira 2013). This wilderness harbors the richest avifauna in the world: 1,294 known species, of which 263 are endemic to this biome (Mittermeier *et al.* 2003). Not surprisingly, Brazil has the world's second most diverse avifauna, with 1,840 species (Silveira 2013). Despite such avian diversity, only 3 tick species are known in Brazil to use birds as primary hosts for all parasitic stages: *Argas miniatus* Koch, 1844, a parasite of domestic fowl, and *Ixodes auritulus* Neumann, 1904 and *Ixodes paranaensis* Barros-Battesti, Arzua, Pichorim & Keirans, 2003, parasites of wild birds (Arzua *et al.* 1994, Arzua & Barros-Battesti 1999, Barros-Battesti *et al.* 2003, Dantas-Torres *et al.* 2009). Curiously, accidental infestations by *Rhipicephalus sanguineus* (Latreille, 1806) have been reported on native and non-native birds in Brazil (Diogo *et al.* 2003, Szabó *et al.* 2008, Luz *et al.* 2012). For the most part, however, studies have reported the occurrence of immature stages (larvae and nymphs) of *Amblyomma* spp. on wild birds that were captured in different areas of the Brazilian Cerrado and Atlantic Forest biomes (Marini *et al.* 1996, Neves *et al.* 2000, Arzua *et al.* 2003, Storni *et al.* 2005, Labruna *et al.* 2007, Ogrzewalska *et al.* 2008, 2009, 2011b, 2012, Tolesano-Pascoli *et al.* 2010, Luz *et al.* 2012, Santolin *et al.* 2012, Pacheco *et al.* 2012, Amaral *et al.* 2013, Pascoal *et al.* 2013, Sanches *et al.* 2013, Torga *et al.* 2013). Within the Amazon biome, only a single Brazilian study, in the State of Pará, has systematically evaluated wild birds for ticks (Ogrzewalska *et al.* 2010). The goal of our

research was to report the prevalence of ticks on wild birds in two undisturbed areas of the Brazilian Amazon.

Materials and methods

During the months of April, July and October 2012, wild birds were captured in two areas of the Brazilian Amazon forest, one located in the municipality of Santa Isabel do Rio Negro (0°35'S, 64°55'W), State of Amazonas, and another in Amazon National Park (4°38'S, 56°28'W), Municipality of Itaituba, State of Pará. Birds were captured using 30–50 mist nets (mesh = 35 mm) 12 m long and 2.5 m high. Nets were opened from sunrise until midday and were monitored every 30 min. Bird species nomenclature follows the South American Classification Committee (Remsen *et al.* 2011). Every captured bird was examined for ticks by carefully checking its entire body and by deflecting the feathers.

Any tick found attached to a bird was removed with forceps, preserved in 95% ethanol, and sent to the laboratory for taxonomic identification based on current literature (Barros-Battesti *et al.* 2006, Martins *et al.* 2010, 2013). Ticks collected in this study have been deposited in the Coleção Nacional de Carrapatos (CNC), Faculty of Veterinary Medicine, University of São Paulo (accession numbers: CNC 2385–2398).

Results and discussion

Overall, 581 wild birds representing 118 species were captured and examined for ticks, but only 18 individual birds were found to be parasitized (3.1% prevalence). A total of 24 ticks (8 larvae and 16 nymphs) of 4 tick species were identified: *Amblyomma calcaratum* Neumann, 1899 (7 nymphs), *Amblyomma geayi* Neumann, 1899 (1 nymph), *Amblyomma humerale* Koch, 1844 (1 nymph), *Amblyomma longirostre* (Koch, 1844) (7 nymphs), and *Amblyomma* sp. (8 larvae) (Table 1). In Santa Isabel do Rio Negro, a total of 153 birds representing 44 species were sampled; 5 birds (3.3% prevalence) were infested by ticks in this area. In Itaituba, a total of 428 birds representing 97 species were sampled; 13 birds (3.0% prevalence) were infested by ticks in this area.

Bird species sampled in the municipality of Santa Isabel do Rio Negro but not found infested by ticks were (number of individuals in parentheses): Columbiformes, Columbidae: *Geotrygon montana* (1); Galbuliformes, Bucconidae: *Malacoptila fusca* (1); Apodiformes, Trochilidae: *Thalurania furcata* (1), *Phaethornis bourcieri* (3), *Phaethornis ruber* (1); Passeriformes, Conopophagidae: *Conopophaga aurita* (4); Polioptilidae: *Microbates collaris* (5); Scleruridae: *Sclerurus caudacutus* (1); Turdidae: *Turdus albicollis* (2); Tyrannidae: *Ramphotrigon ruficauda* (1); Tityridae: *Schiffornis turdina* (3), *Terenotriccus erythrurus* (1); Vireonidae: *Hylophilus brunneiceps* (1), *Hylophilus ochraceiceps* (1); Pipridae: *Chiroxiphia pareola* (1), *Lepidothrix coronata* (10), *Pipra erythrocephala* (3); Rhynchocyclidae: *Chondestes subbrunneus* (1), *Corythopsis torquatus* (1), *Mionectes oleaginous* (1); Furnariidae: *Automolus infuscatus* (10), *Automolus rubiginosus* (1), *Hylocisthes subulatus* (3), *Xenops minutus* (3); Dendrocolaptidae: *Deconychura stictolaema* (1), *Dendrocincla fuliginosa* (4), *Dendrocincla merula* (3), *Glyphorhynchus spirurus* (5); Thamnophilidae: *Cymbilaimus lineatus* (1), *Dichrozona cincta* (1), *Epinecrophylla haematonota* (3), *Gymnopathys leucaspis* (7), *Hylophylax naevius* (6), *Hypocnemis hypoxantha* (1), *Myrmoborus myotherinus* (3), *Myrmotherula longipennis* (3), *Phlegopsis erythroptera* (2), *Pithys albifrons* (11), *Thamnomanes caesius* (9), *Thamnophilus murinus* (1), and Tyrannoidea: *Platyrinchus platyrhynchus* (2).

TABLE 1. Larval (L) and nymphal (N) ticks collected from birds in two areas of the Amazon forest in Brazil: Santa Isabel do Rio Negro municipality, State of Amazonas (AM), and Itaituba Municipality, State of Pará (PA).

Birds					
Order	Family	Species	No. Infested/ No. examined (%)	Tick species (No. of specimens)	Area
Falconiformes	Falconidae	<i>Micrastur ruficollis</i>	1/1 (100)	<i>Amblyomma longirostre</i> (1N)	PA
Passeriformes	Cardinalidae	<i>Cyanoloxia cyanooides</i>	1/4 (25.0)	<i>Amblyomma</i> sp. (1L)	PA
	Dendrocolaptidae	<i>Deconychura longicauda</i>	1/4 (25.0)	<i>A. longirostre</i> (1N)	PA
		<i>Dendrocincla merula</i>	1/6 (16.7)	<i>A. longirostre</i> (1N)	PA
		<i>Dendrocolaptes certhia</i>	1/2 (50.0)	<i>A. longirostre</i> (1N)	PA
		<i>Glyphorhynchus spirurus</i>	1/20 (5.0)	<i>A. longirostre</i> (1N)	PA
		<i>Xiphorhynchus ocellatus</i>	1/5 (20)	<i>Amblyomma calcaratum</i> (1N)	AM
	Pipridae	<i>Lepidothrix nattereri</i>	1/10 (10.0)	<i>Amblyomma</i> sp. (1L)	PA
	Thamnophilidae	<i>Epinecrophylla leucophthalma</i>	1/9 (11.1)	<i>A. longirostre</i> (1N)	PA
		<i>Thamnophilus aethiops</i>	3/8 (37.5)	<i>A. calcaratum</i> (5N), <i>A. longirostre</i> (1N)	AM
		<i>Thamnomanes caesius</i>	2/6 (33.3)	<i>Amblyomma geayi</i> (1N), <i>Amblyomma humerale</i> (1N)	PA
		<i>Willisornis poecilinotus</i>	1/17 (5.9)	<i>A. calcaratum</i> (1N)	AM
	Thraupidae	<i>Ramphocelus carbo</i>	2/12 (16.7)	<i>Amblyomma</i> sp. (5L)	PA
	Tyrannidae	<i>Knipolegus poeilocercus</i>	1/6 (16.7)	<i>Amblyomma</i> sp. (1L)	PA

Bird species sampled in the municipality of Itaituba but not found infested by ticks were (number of individuals in parentheses): Piciformes, Picidae: *Celeus elegans* (3); Coraciiformes, Alcedinidae: *Chloroceryle aenea* (2); Columbiformes, Columbidae: *Geotrygon montana* (1), *Leptotila rufaxilla* (5); Galbuliformes, Bucconidae: *Malacoptila rufa* (2), *Monasa nigrifrons* (3); Galbulidae: *Galbula cyanicollis* (7), *Jacamerops aureus* (1); Apodiformes, Trochilidae: *Campylopterus largipennis* (2), *Glaucis hirsutus* (8), *Phaethornis malaris* (18), *Phaethornis philippii* (3), *Phaethornis ruber* (4), *Thalurania furcata* (17), *Threnetes leucurus* (1); Passeriformes, Cotingidae: *Lipaugus vociferans* (1); Dendrocolaptidae: *Certhiasomus stictolaemus* (2), *Dendrocincla fuliginosa* (1), *Dendroplex picus* (4), *Sittasomus griseicapillus* (1), *Xiphorhynchus elegans* (6), *Xiphorhynchus guttatus* (2), *Xiphorhynchus obsoletus* (3), *Xiphorhynchus ocellatus* (1); Emberizidae: *Arremon taciturnus* (2), *Sporophila angolensis* (2); Formicariidae: *Formicarius colma* (2); Furnariidae: *Automolus ochrolaemus* (3), *Automolus paraensis* (2), *Craniolaema vulpina* (2), *Hylocisthes subulatus* (1), *Philydor erythrocerum* (1), *Philydor pyrrhodes* (4), *Xenops minutus* (4); Pipridae: *Dixiphia pipra* (1), *Heterocercus linteatus* (12), *Lepidothrix vilasboasi* (2), *Pipra fasciicauda* (1), *Pipra rubrocapilla* (7); Polioptilidae: *Ramphocaenus melanurus* (1); Rhynchocyclidae: *Corythopis torquatus* (1), *Mionectes macconnelli* (2), *Rhynchocyclus olivaceus* (1), *Tolmomyias flaviventris* (1), *Tolmomyias sulphurescens* (2); Scleruridae: *Sclerurus caudacutus* (1); Thamnophilidae: *Hylophylax naevius* (2), *Hylophylax punctulatus* (5), *Hypocnemis striata* (21), *Hypocnemoides maculicauda* (8), *Myrmeciza ferruginea* (1), *Myrmoborus myotherinus* (13), *Myrmornis torquata* (1), *Myrmotherula axillaris* (15), *Myrmotherula hauxwelli* (4), *Myrmotherula longipennis* (11), *Phlegopsis nigromaculata* (10), *Rhegmatorhina berlepschi* (3), *Schistocichla leucostigma* (2), *Thamnomanes saturninus* (11), *Thamnophilus aethiops* (3), *Thamnophilus amazonicus* (1), *Thamnophilus nigrocinereus* (13), *Thamnophilus schistaceus* (2), *Willisornis poecilinotus* (4); Thraupidae: *Lanio cristatus* (2), *Lanio surinamus* (2), *Saltator coerulescens* (5), *Saltator maximus* (2); Tityridae: *Myiobius barbatus* (2), *Onychorhynchus coronatus* (2), *Schiffornis turdina* (6), *Terenotriccus erythrurus* (2); Troglodytidae: *Cantorchilus leucotis* (10), *Microcerculus marginatus* (1), *Pheugopedius genibarbis* (3); Turdidae: *Turdus albicollis* (2), *Turdus fumigatus* (7); Tyrannidae: *Attila spadiceus* (4), *Cnemotriccus fuscatus* (5), *Myiarchus ferox* (1), *Ramphotrigon ruficauda* (2), *Rhytipterna simplex* (2); Vireonidae: *Hylophilus ochraceiceps* (2), and Tyrannoidea: *Platyrinchus platyrhynchus* (2), *Platyrinchus saturatus* (1).

In the present study, a 3.0–3.3% prevalence of tick infestation was reported for birds from two undisturbed areas of the Brazilian Amazon. The only previous study with birds in this biome reported 40.2% tick prevalence among 331 birds (mostly Passeriformes) captured in a disturbed area of the State of Pará (Ogrzewalska *et al.* 2010). Because Ogrzewalska *et al.* (2010) sampled birds during November, and we sampled during April, July and October, it is possible that these contrasting prevalence values were affected by season. On the other hand, the contrasting disturbance status of the areas should also be considered, since a recent study in the Atlantic Forest biome in southeastern Brazil reported significantly higher prevalence of ticks on birds from degraded forest patches when compared to less disturbed forest patches (Ogrzewalska *et al.* 2011a). In this same study, degraded forest patches had significantly lower bird diversity than less disturbed areas. If we apply a simple biodiversity index (no. bird species/no. individual birds) (Sokal & Rohlf 1995) to the two areas in the present study (Santa Isabel do Rio Negro and Itaituba), similar values (0.287 and 0.225, respectively) result. In contrast, a lower diversity index (0.169) applies to the Amazonian area studied by Ogrzewalska *et al.* (2010), where much higher tick prevalence was found on birds. While these results suggest that, similar to the Atlantic Forest biome, tick infestations on Amazonian passeriform birds are higher in disturbed fragments with lower bird diversity, more studies are needed to confirm such observations.

Although we found immature stages of four *Amblyomma* species on birds (mostly Passeriformes), the adult stages of these ticks have a distinct preference for non-avian hosts: adults of *A. calcaratum* feed chiefly on anteaters, *A. geayi* on sloths, *A. humerale* on tortoises, and *A. longirostre* on porcupines (Aragão 1936, Labruna *et al.* 2005). Except for *A. longirostre*, for which passerine birds have been shown to be principal hosts of larvae and nymphs (Nava *et al.* 2010), little information is available regarding host usage by the immature stages of the other three *Amblyomma* species. Our results, in conjunction with another recent study (Ogrzewalska *et al.* 2010), suggest that passeriform birds may also be important hosts for the immature stages of *A. calcaratum*, *A. geayi* and *A. humerale* in the Amazon biome.

In the present study, we provide the following tick-host records for the first time: *A. longirostre* on *Micrastur ruficollis*, *Dendrocolaptes certhia*, *Epinecrophylla leucophthalma* and *Thamnophilus aethiops*; *A. calcaratum* on *Xiphorhynchus ocellatus*, *Thamnophilus aethiops* and *Willisornis poecilinotus*; *A. geayi* on *Thamnomanes caesius*; and *Amblyomma* sp. on *Lepidothrix nattereri* and *Knipolegus poecilocercus*. Tick-host associations found in the present study but also previously reported are: *A. longirostre* on *Deconychura longicauda*, *Dendrocincla merula* and *Glyphorhynchus spirurus* (Ogrzewalska *et al.* 2010, 2011b); and *A. humerale* on *T. caesius* (Ogrzewalska *et al.* 2010).

Finally, all four *Amblyomma* species found in the present study have been reported to carry bacteria of the genus *Rickettsia*, such as *Rickettsia parkeri* in *A. calcaratum* (Ogrzewalska *et al.* 2013), *R. amblyommii* in *A. longirostre* and *A. geayi* (Ogrzewalska *et al.* 2008, 2010), and *Rickettsia bellii* in *A. humerale* (Labruna *et al.* 2004). While these *Amblyomma* species are not considered to be important human-biting ticks, they could be involved in enzootic maintenance cycles of rickettsial organisms, and in this case, birds could play an important role in the dissemination of infected ticks, as reported for other tick-borne agents on other continents (Hasle 2013). In fact, records exist of *A. calcaratum*, *A. humerale*, and *A. longirostre* in North America, where these ticks are not established but were transported via migratory birds from the Neotropical Region (Bloemer *et al.* 1987, Scott *et al.* 2001, Morshed *et al.* 2005).

Acknowledgements

We are grateful to Claudeir Ferreira Vargas, Marcelo Barreiros, Gabriel Leite and Thiago Bicudo for field assistance and bird identification. Bird capture and sample collection were approved by the Brazilian government through the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA). This study was supported by Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), and Fundação de Amparo à Pesquisa do Estado do Amazonas (FAPEAM).

References

- Amaral, H.L.C., Bergmann, F.B., dos Santos, P.R., Krüger, R.F. & Gracioli, G. (2013) Community of arthropod ectoparasites of two species of *Turdus* Linnaeus, 1758 (Passeriformes: Turdidae) in southern Rio Grande do Sul, Brazil. *Parasitology Research*, 112, 621–628.
<http://dx.doi.org/10.1007/s00436-012-3174-5>
- Aragão, H.B. (1936) Ixodidas brasileiros e de alguns países limitrophes. *Memórias do Instituto Oswaldo Cruz*, 31, 759–843.
<http://dx.doi.org/10.1590/s0074-02761936000400004>
- Arzua, M., Barros, D.M., Linardi, P.M. & Botelho, J.R. (1994) Noteworthy records of *Ixodes auritulus* Neumann, 1904 (Acari, Ixodida) on birds from Paraná, southern Brazil. *Memórias do Instituto Oswaldo Cruz*,

- 89, 129.
<http://dx.doi.org/10.1590/s0074-02761994000100026>
- Arzua, M. & Barros-Battesti, D.M. (1999) Parasitism of *Ixodes (Multidentatus) auritulus* Neumann (Acari: Ixodidae) on birds from the city of Curitiba, State of Paraná, southern Brazil. *Memórias do Instituto Oswaldo Cruz*, 94, 597–603.
<http://dx.doi.org/10.1590/s0074-02761999000500006>
- Arzua, M., Navarro da Silva, M.A., Famadas, K.M., Beati, L. & Barros-Battesti, D.M. (2003) *Amblyomma aureolatum* and *Ixodes auritulus* Neumann (Acari: Ixodidae) on birds in southern Brazil, with notes on their ecology. *Experimental and Applied Acarology*, 31, 283–296.
<http://dx.doi.org/10.1023/b:appa.0000010381.24903.1c>
- Barros-Battesti, D.M., Arzua, M., Pichorim, M. & Keirans, J.E. (2003) *Ixodes (Multidentatus) paranaensis* n. sp. (Acari: Ixodidae) a parasite of *Streptoprocne biscutata* (Sclater 1865) (Apodiformes: Apodidae) birds in Brazil. *Memórias do Instituto Oswaldo Cruz*, 98, 93–91.
<http://dx.doi.org/10.1590/s0074-02762003000100013>
- Barros-Battesti, D.M., Arzua, M. & Bechara, G.H. (2006) *Carrapatos de importância médico-veterinária da Região Neotropical: um guia ilustrado para identificação de espécies*. São Paulo, Vox/ICTTD-3/Butantan. 223 pp.
- Bloemer, S.R., Russell, C.L. & Keirans, J.E. (1987) *Amblyomma calcaratum* (Acari: Ixodidae), a Central and South American tick, found in Kentucky, USA. *Journal of Medical Entomology*, 24, 117.
- Dantas-Torres, F., Bernardi, L.F.O., Souza-Silva, M., Ferreira, R.L., Onofrio, V.C., Barros-Battesti, D.M. & Labruna, M.B. (2009) New records of *Ixodes paranaensis* (Acari: Ixodidae) from Minas Gerais, south-eastern Brazil. *Systematic & Applied Acarology*, 14, 213–215.
- Diogo, A.A.R., Guerim, L., Pires, J.R., Couto, A.L.G. & Serra-Freire, N.M. (2003) Parasitismo por *Rhipicephalus sanguineus* Latreille, 1806 em *Columba livia* Linnaeus na cidade do Rio de Janeiro, Brasil. *Entomologia y Vetores*, 10, 277–280.
- Hasle, G. (2013) Transport of ixodid ticks and tick-borne pathogens by migratory birds. *Frontiers in Cellular and Infection Microbiology*, 3, 48.
<http://dx.doi.org/10.3389/fcimb.2013.00048>
- Labruna, M.B., Whitworth, T., Bouyer, D.H., McBride, J.W., Camargo, L.M.A., Camargo, E.P., Popov, V. & Walker, D.H. (2004) *Rickettsia bellii* and *Rickettsia amblyommii* in *Amblyomma* ticks from the State of Rondônia, western Amazon. *Journal of Medical Entomology*, 41, 1073–1081.
<http://dx.doi.org/10.1603/0022-2585-41.6.1073>
- Labruna, M.B., Camargo, L.M.A., Terrassini, F.A., Ferreira, F., Schumaker, T.S. & Camargo, E.P. (2005) Ticks (Acari: Ixodidae) from the State of Rondônia, western Amazon, Brazil. *Systematic & Applied Acarology*, 10, 17–32.
- Labruna, M.B., Sanfilippo, L.F., Demetrio, C., Menezes, A.C., Pinter, A., Guglielmo, A.A. & Silveira, L.F. (2007) Ticks collected on birds in the State of São Paulo, Brazil. *Experimental and Applied Acarology*, 43, 147–160.
<http://dx.doi.org/10.1007/s10493-007-9106-x>
- Luz, H.R., Faccini, J.L.H., Landulfo, G.A., Berto, B.P. & Ferreira, I. (2012) Bird ticks in an area of the Cerrado of Minas Gerais State, southeast Brazil. *Experimental and Applied Acarology*, 58, 89–99.
<http://dx.doi.org/10.1007/s10493-012-9572-7>
- Marini, M.A., Reinert, B.L., Bornschein, M.R., Pinto, J.C. & Pichorim, M.A. (1996) Ecological correlates of ectoparasitism on Atlantic Forest birds, Brazil. *Ararajuba*, 4, 93–102.
- Martins, T.F., Onofrio, V.C., Barros-Battesti, D.M. & Labruna, M.B. (2010) Nymphs of the genus *Amblyomma* (Acari: Ixodidae) of Brazil: descriptions, redescriptions, and identification key. *Ticks and Tick-borne Diseases*, 1, 75–99.
<http://dx.doi.org/10.1016/j.ttbdis.2010.03.002>
- Martins, T.F., Scofield, A., Oliveira, W.B.L., Nunes, P.H., Ramirez, D.G., Barros-Battesti, D.M., Sá, L.R.M., Ampuero, F., Souza Jr., J.C. & Labruna, M.B. (2013) Morphological description of the nymphal stage of *Amblyomma geayi*, and new nymphal records of *Amblyomma parkeri*. *Ticks and Tick-borne Diseases*, 4, 181–184.
<http://dx.doi.org/10.1016/j.ttbdis.2012.11.015>
- Mittermeier, R.A., Mittermeier, C.G., Brooks, T.M., Pilgrim, J.D., Konstant, W.R., Fonseca, G.A.B. & Kormos, C. (2003) Wilderness and biodiversity conservation. *Proceedings of the National Academy of Sciences*, 100, 10309–10313.

- <http://dx.doi.org/10.1073/pnas.1732458100>
- Morshed, M.G., Scott, J.D., Fernando, K., Beati, L., Mazerolle, D.F., Geddes, G. & Durden, L.A. (2005) Migratory songbirds disperse ticks across Canada, and first isolation of the Lyme disease spirochete, *Borrelia burgdorferi*, from the avian tick, *Ixodes auritulus*. *Journal of Parasitology*, 91, 780–790.
<http://dx.doi.org/10.1645/ge-3437.1>
- Nava, S., Velazco, P.M. & Guglielmo, A.A. (2010) First record of *Amblyomma longirostre* (Koch, 1844) (Acari: Ixodidae) from Peru, with a review of this tick's host relationships. *Systematic & Applied Acarology*, 15, 21–30.
- Neves, R.L., Farias, A.M.I., Telino Jr., W.R., Arzua, M., Botelho, M.C.N. & Lima, M.C.A. (2000) Ectoparasitismo em aves silvestres (Passeriformes-Emberizidae) de Mata Atlântica, Igarassu, Pernambuco. *Melopsittacus*, 3, 64–71.
- Ogrzewalska, M., Pacheco, R.C., Uezu, A., Ferreira, F. & Labruna, M.B. (2008) Ticks (Acari: Ixodidae) infesting wild birds in an Atlantic Forest area in the State of São Paulo, Brazil, with isolation of *Rickettsia* from the tick *Amblyomma longirostre*. *Journal of Medical Entomology*, 45, 770–774.
[http://dx.doi.org/10.1603/0022-2585\(2008\)45\[770:taiwb\]2.0.co;2](http://dx.doi.org/10.1603/0022-2585(2008)45[770:taiwb]2.0.co;2)
- Ogrzewalska, M., Pacheco, R.C., Uezu, A., Richtzenhein, L.J., Ferreira, F. & Labruna, M.B. (2009) Ticks (Acari: Ixodidae) infesting birds in an Atlantic rain forest region of Brazil. *Journal of Medical Entomology*, 46, 1225–1229.
<http://dx.doi.org/10.1603/033.046.0534>
- Ogrzewalska, M., Uezu, A. & Labruna, M.B. (2010) Ticks (Acari: Ixodidae) infesting birds in the eastern Amazon, northern Brazil, with notes on rickettsial infection in ticks. *Parasitology Research*, 106, 809–816.
<http://dx.doi.org/10.1007/s00436-010-1733-1>
- Ogrzewalska, M., Uezu, A., Jenkins, C.N. & Labruna, M.B. (2011a) Effect of forest fragmentation on tick infestations of birds and tick infection rates by *Rickettsia* in the Atlantic Forest of Brazil. *EcoHealth*, 8, 320–331.
<http://dx.doi.org/10.1007/s10393-011-0726-6>
- Ogrzewalska, M., Uezu, A. & Labruna, M.B. (2011b) Ticks (Acari: Ixodidae) infesting wild birds in the Atlantic Forest in northeastern Brazil, with notes on rickettsial infection in ticks. *Parasitology Research*, 108, 665–670.
<http://dx.doi.org/10.1007/s00436-010-2111-8>
- Ogrzewalska, M., Saraiva, D.G., Moraes-Filho, J., Martins, T.F., Costa, F.B., Pinter, A. & Labruna, M.B. (2012) Epidemiology of Brazilian spotted fever in the Atlantic Forest, State of São Paulo, Brazil. *Parasitology*, 139, 1283–1300.
<http://dx.doi.org/10.1016/j.ttbdis.2012.07.001>
- Ogrzewalska, M., Martins, T., Capek, M., Literak, I. & Labruna, M.B. (2013) A *Rickettsia parkeri*-like agent infecting *Amblyomma calcaratum* nymphs from wild birds in Mato Grosso do Sul, Brazil. *Ticks and Tick-borne Diseases*, 4, 145–147.
<http://dx.doi.org/10.1016/j.ttbdis.2012.07.001>
- Pacheco, R.C., Arzua, M., Nieri-Bastos, F.A., Moraes-Filho, J., Marcili, A., Richtzenhein, L.J., Barros-Battesti, D.M. & Labruna, M.B. (2012) Rickettsial infection in ticks (Acari: Ixodidae) collected on birds in southern Brazil. *Journal of Medical Entomology*, 49, 710–716.
<http://dx.doi.org/10.1603/me11217>
- Pascoal, J.O., Amorim, M.P., Martins, M.M., Melo, C., Júnior, E.L.S., Ogrzewalska, M., Labruna, M.B. & Szabó, M.P.J. (2013) Ticks on birds in a savanna (Cerrado) reserve on the outskirts of Uberlândia, Minas Gerais, Brazil. *Revista Brasileira de Parasitologia Veterinária*, 22, 46–52.
<http://dx.doi.org/10.1590/s1984-29612013005000004>
- Remsen, J.V.Jr., Cadena, C.D., Jaramillo, A., Nores, M., Pacheco, J.F., Pérez-Emán, J., Robbins, M.B., Stiles, F.G. Stotz, D.F. & Zimmer, K.J. (2011) A Classification of the Bird Species of South America. *American Ornithologists' Union*. <http://www.museum.lsu.edu/~Remsen/SACCBaseline.html>
- Sanches, G.S., Martins, T.F., Lopes, I.T., Costa, L.F.S., Nunes, P.H., Camargo-Mathias, M.I. & Labruna, M.B. (2013) Ticks infesting birds in Atlantic Forest fragments in Rio Claro, State of São Paulo, Brazil. *Revista Brasileira de Parasitologia Veterinária*, 22, 6–12.
<http://dx.doi.org/10.1590/s1984-29612013000100003>
- Santolin, I.D.A.C., Luz, H.R., Alchorne, N.M., Pinheiro, M.C., Melinski, R.D., Faccini, J.L.H., Ferreira, I. & Famadas, K.M. (2012) Ticks on birds caught on the campus of the Federal Rural University of Rio de

- Janeiro, Brazil. *Revista Brasileira de Parasitologia Veterinária*, 21, 213–218.
<http://dx.doi.org/10.1590/s1984-29612012000300007>
- Scott, J.D., Fernando, K., Banerjee, S.N., Durden, L.A., Byrne, S.K., Banerjee, M., Mann, R.B., & Morshed, M.G. (2001) Birds disperse ixodid (Acari: Ixodidae) and *Borrelia burgdorferi*-infected ticks in Canada. *Journal of Medical Entomology*, 38, 493–500.
<http://dx.doi.org/10.1603/0022-2585-38.4.493>
- Silveira, L.F. (2013) Novas aves da Amazônia. *Revista Pesquisa FAPESP*, 207, 19–23.
- Sokal, R.R., & Rohlf, F.J. (1995) *Biometry: The Principles and Practices of Statistics in Biological Research* 3rd ed. W.H. Freeman and Company, New York, 880 p.
- Storni, A., Alves, M.A.S. & Valim, M.P. (2005) Ácaros de penas e carrapatos (Acari) associados a *Turdus albicollis* (Aves, Muscicapidae) em uma área de Mata Atlântica da Ilha Grande, Rio de Janeiro, Brasil. *Revista Brasileira de Zoologia*, 22, 419–423.
<http://dx.doi.org/10.1590/s0101-81752005000200017>
- Szabó, M.P.J., Tolesano-Pascoli, G.V., Marçal Júnior, O., Franchin, A.G. & Torga, K. (2008) Brown dog tick *Rhipicephalus sanguineus* parasitizing the bird *Coereba flaveola* in the Brazilian cerrado. *Ciência Rural*, 38, 543–545.
<http://dx.doi.org/10.1590/s0103-84782008000200041>
- Tolesano-Pascoli, G.V., Torga, K., Franchin, A.G., Ogrzewalska, M., Gerardi, M., Olegário, M.M., Labruna, M.B., Szabó, M.P. & Marçal Júnior, O. (2010) Ticks on birds in a forest fragment of Brazilian cerrado (savanna) in the municipality of Uberlândia, State of Minas Gerais, Brazil. *Revista Brasileira de Parasitologia Veterinária*, 19, 244–248.
<http://dx.doi.org/10.1590/s1984-29612010000400010>
- Torga, K., Tolesano-Pascoli, G.V., Vasquez, J.B., Silva Jr, E.L., Labruna, M.B., Martins, T.F., Ogrzewalska, M. & Szabó, M.P.J. (2013) Ticks on birds from Cerrado forest patches along the Uberabinha River in the Triângulo Mineiro region of Minas Gerais, Brazil. *Ciência Rural*, 43, 1852–1857.
<http://dx.doi.org/10.1590/s0103-84782013005000121>

Accepted by Richard G. Robbins: 10 Sept. 2014; published 1 Dec. 2014