Parasitol Res (2012) 111:1731–1742
DOI 10.1007/s00436-012-3016-5

ORIGINAL PAPER

Chewing lice (Insecta, Phthiraptera) and feather mites (Acari, Astigmata) associated with birds of the Cerrado in Central Brazil

Alexandre Magno Junqueira Enout · Débora Nogueira Campos Lobato · Francisco Carvalho Diniz · Yasmine Antonini

Received: 22 March 2011 / Accepted: 17 June 2012 / Published online: 8 July 2012
© Springer-Verlag 2012

Abstract The association of chewing lice and feather mites with wild birds of riparian forest was investigated in the Cerrado biome, Tocantins State, Brazil. The birds were captured with mist nets between July 2008 and March 2009. Ectoparasites were collected by the dust-ruffling technique. Infestation rates were determined by the sampling prevalence, abundance, and mean intensity of ectoparasites. A total of 1,479 chewing lice were collected that were distributed in 3 families and 18 genera, of which 15 taxa were identified to the species level. Sixteen genera of feather mites were found, and 10 species were identified. A high prevalence rate of chewing lice and feather mites was found in non-Passeriformes (66.7 and 50.0 %) and Passeriformes (57.8 and 75.6 %) birds. New host–parasite associations were registered for two species of chewing lice and for four species of feather mites, thus expanding the geographical distribution in Brazil of six chewing lice species. This is the first study of the ectoparasites of wild birds to be conducted in this region of Brazil.

A. M. J. Enout · Y. Antonini (✉)
Laboratory for Biodiversity, Department of Biological Sciences,
Institute of Biological and Exact Sciences,
Federal University of Ouro Preto,
Campus Morro do Cruzeiro, Bauxita,
35.400-000 Ouro Preto, MG, Brazil
e-mail: antonini.y@gmail.com

A. M. J. Enout
e-mail: aleenout@hotmail.com

D. N. C. Lobato · F. C. Diniz
Laboratory for Insects Behavior, Department of Ecology, Institute of Biological Sciences, Federal University of Minas Gerais,
Avenida Antônio Carlos, 6627, caixa postal 486, 31.270-901
Belo Horizonte, MG, Brazil

D. N. C. Lobato
e-mail: debora_bio@yahoo.com.br

F. C. Diniz
e-mail: chicocdiniz@yahoo.com.br

Introduction

Each individual bird species can present a particular fauna of ectoparasites, and the specific ectoparasites found are related to the order, genera, or even to the species of the host (Hopkins 1942; Peterson 1975). Chewing lice (Insecta, Phthiraptera) and feather mites (Acari, Astigmata) are both the most abundant and diverse ectoparasites of birds (Johnson and Clayton 2003; Proctor 2003) although some authors do not consider feather mites as parasites, but as commensals or mutualists (Blanco et al. 1997, 2001). Both are permanent and obligatory ectosymbionts–parasites that spend their entire life cycle on the bird host, giving them their high specificity (Dabert and Mironov 1999; Marshall 1981).

Two suborders of chewing lice have been found to parasitize birds: Amblycera and Ischnocera (Johnson and Clayton 2003). These lice have chewing mouthparts, the characteristic for which they are named, although some species feed on blood (Nelson 1972).

Feather mites are found on all families of birds. The suborder Astigmata has the highest diversity of bird mites and includes the superfamilies Analgoidea and Pterolichoidea.

Work related to avian ectoparasites in Brazil was initiated with Lindolpho Rocha Guimarães and Hebert F. Berla with a taxonomic focus in chewing lice and feather mites, respectively (Berla 1958, 1959a, b, c, 1960; Guimarães 1936, 1945). Currently, new taxonomic studies have broadened the knowledge about the taxonomic fauna of Brazil (Hernandes and Valim 2005, 2006; Hernandes et al. 2007; Oniki 2000, 2004; Valim and Hernandes 2006, 2008, 2010; Valim et al. 2011). Some studies have been conducted on specific hosts such as *Ramphocelus carbo* (Carvalho and Serra-Freire 2001), *Turdus albicollis* (Storni et al. 2005), and *Turdus leucomelas* (Enout et al. 2009). Other studies, focusing on avian communities, were conducted in regions in the

Atlantic Rainforest from Paraná (Marini et al. 1996) and Pernambuco States (Lyra-Neves et al. 2000, 2003, 2005; Roda and Farias 1999a, b, 2007). On the Cerrado (Brazilian Savanna), studies were conducted in Minas Gerais (Marini and Couto 1997; Oniki and Willis 1993) and Distrito Federal (Kanegae et al. 2008). Despite these studies, the knowledge about avian ectoparasite infestations in Neotropical birds in Brazil is still very limited (Clayton et al. 1992; Klink and Machado 2005).

Recent studies have shown the important role of parasites in the decline of wild bird populations; therefore, a basic knowledge of host–parasite associations is a priority for conservation purposes (Alitzer et al. 2003). Therefore, the objective of this study is to contribute new data about host–parasite associations in the Cerrado region of Central Brazil, to increase the knowledge of the geographical distribution of ectoparasites found in the study area, to determine the rates of infestation prevalence of feather mites and chewing lice, and to determine the abundance and intensity of the infestations by chewing lice on the avian host.

Materials and methods

Study area

This study was conducted in riparian forests in the Cerrado, the central region of Brazil, in Tocantins State. The samplings were conducted in three protected areas: (1) the Lageado State Reserve (10°10′36″ S 48°12′08″ W), (2) the Cesamar Municipal Reserve (10°12′27″ S, 48°18′57″ W), and (3) the Ecotropical Institute (10°16′52″ S, 48°09′35″ W). The data collected in the three areas were clustered to analyze the parasitism rates because the areas are very close, within 15 km of each other, and are subjected to the same regional climatic regime.

The Cerrado is an ecosystem that resembles a savanna, with a predominance of open, shrub vegetation and patches with riparian forest. This region is located in the tropical climactic zone, which implies a relatively high and constant temperature regime throughout the year (Eiten 1972; Ribeiro and Walter 1998).

Sampling data

We aimed to catch birds only in riparian forests, limiting the research to one environment. However, all birds caught were examined, with the exception of hummingbirds (Apodiformes, Trochilidae), birds that are sensitive and need special care and handling.

Field work was conducted in July, October, and November of 2008 and February and March of 2009. Birds were caught with mist nets of 36 mm, 10×2.5 m, opened between 05:00 and 12:00 am. Classification followed the one proposed by the American Ornithologists' Union (Remsen et al. 2011).

This study was conducted with authorization of the Brazilian Ringing Agency (CEMAVE/IBAMA, license no. 905905: license to capture and collect biological material: 158/06). Each bird received a metal ring provided by the official Brazilian Ringing Agency and was released after it was checked for ectoparasites.

The ectoparasites were collected using the dust-ruffling technique for an accurate estimation of the total abundance of bird lice (Walther and Clayton 1997). We used a specific product for bird ectoparasite control that contains 0.1 % pyrethrin, an insecticide that is not harmful to bird health and is efficient for collecting almost all ectoparasites (Clayton and Tompkins 1995; Clayton and Drown 2001). Recaptured birds were not examined because of the persistence of the insecticide. For chewing lice, the number of males, females, and nymphs was counted. However, this method was not appropriate for an accurate, quantitative assessment for the feather mites, so only qualitative data were examined for that ectosymbionts.

The chewing lice were mounted according to the method proposed by Palma (1978), and the mites were mounted according to the method proposed by Flechtmann (1990). The classification of the chewing lice to the genus level was done following Price et al. (2003). The classification to the genus level of the feather mites, when possible, was done following the dichotomic keys in Gaud and Atyeo (1996) and posterior descriptions of genus (Hernandes et al. 2007; Mironov et al. 2008; Valim and Hernandes 2010). The identification of the ectoparasites to the species level, when possible, was done with literature specific to each genus found. The specimens are still under study and will be added soon to the collection of the University of São Paulo Zoological Museum.

Parasitism rate analysis

The infestation prevalence of chewing lice was evaluated only for bird species with a minimum of five collected individuals. For feather mites, the prevalence was assessed for all species. The abundance and mean intensity of each species of chewing lice on avian hosts were determined according to Bush et al. (1997).

Results

Chewing lice

Chewing lice were found on eight species of the 12 species of non-Passeriformes that were examined (66.7 %). Of the Passeriformes, 45 species were analyzed, with 26 presenting infestation (57.8 %).

Two new host–parasites associations were found, and six species of chewing lice were found for the first time in Brazil, thereby increasing the geographic distribution of this group (Table 1).

A total of 1,474 individuals were collected, representing 288 males, 379 females, and 807 nymphs. They were distributed in two suborders and three families: suborder Amblycera, families Menoponidae (159 males, 134 females, and 350 nymphys (N)) and Ricinidae (288 males, 379 females, and 807 N), and suborder Ischnocera, family Philopteridae (126 males, 232 females, and 447 N). Identification to the species level was achieved for 15 taxa distributed in 9 genera, whereas the other 9 taxa were identified to the genus level.

Menoponidae—Six species were found: *Menacanthus eurysternus* (Burmeister 1838), *Menacanthus dendroicae* Price 1977, *Myrsidea taciturni* Price and Dalgleish 2007, *Myrsidea seminuda* Eichler 1951, *Myrsidea ramphoceli* Price and Dalgleish 2006, *Myrsidea lightae* Price et al. 2008, and *Hohorstiella paladinella* Hill and Tuff 1978, *Machaerilaemus aff. tangarae* Price et al. 2002; individuals of the genus *Psittacobrosus* Carriker 1954, were also found.

Ricinidae—Identified to the species level: *Ricinus pessimalis* Eichler 1956 and *Ricinus invadens* (Kellogg 1899).

Philopteridae—Five species were found: *Clayiella prionitis* (Denny 1841), *Picicola galbulica* Valim and Linardi 2006, *Columbicola macrourae* (Wilson 1941), *Columbicola timmermanni* Tendeiro 1965, and *Physconelloides ceratoceps* Ewing 1927. Another eight taxa were identified to the genus level: *Brueelia* Kéler 1936, *Tyranniphilopterus* Mey 2004, *Rallicola* Johnson and Harrison 1911, *Mulcticola* Clay and Meinertzhagen 1938, *Picicola* Clay and Meinertzhagen 1938, *Philopterus* Nitzsch 1818, *Mayriphilopterus* Mey 2004, and *Sturnidoecus* Eichler 1944.

The mean intensity of the infestation by different species of chewing lice was between 1 and 122 lice/bird. Considering all species, 18.7 lice/bird were found (Table 1). The prevalence rate of infestation for each species of chewing lice was analyzed for eight bird species that had at least five individuals sampled (Table 2).

Feather mites

Feather mites were found in six species of non-Passeriformes (50.0 %) and in 34 species of Passeriformes (75.6 %). The prevalence of infestation for each species of feather mites was calculated for all hosts. Considering that data on the prevalence of feather mites are rare in Brazil, the same host species with low sample size were analyzed and the results are important parameters for future research (Table 3).

A total of 11 taxa were identified to the species level, distributed in eight genera and four families. Another nine taxa were identified to the genus level. Four new host–parasites associations were observed (Table 3).

The species of feather mites found are distributed in two superfamilies and eight families—Analgoidea: Analgidae, Avenzoariidae, Proctophyllodidae, Psoroptoididae, Xolalgidae, and Trouessartiidae; and Pterolichoidea: Falculiferidae and Pterolichidae.

Analgidae—Represented by the genus *Analges* Nitzsch 1818.

Avenzoariidade—Represented by the genus *Pteronyssoides* Hull 1931.

Proctophyllodidae—Family with the highest diversity of taxa, with six identified to the species level: *Proctophyllodes saltatoris* Atyeo and Braasch 1966, *Diproctophyllodes dielytra* (Trouessart 1883), *Platyacarus sittasomi* Hernandes et al. 2007, *Tyrannidectes amaurochalinus* (Hernandes and Valim 2006), *Amerodectes turdinus* (Berla 1959a, b, c), and *Amerodectes bilineatus* (Berla 1958). Another six taxa were identified to the genus level: *Nycteridocaulus* Atyeo 1966, *Atrichophyllodes* Hernandes et al. 2007, *Tyranniphyllodes* Hernandes et al. 2007, *Nanopterodectes* Mironov 2009, *Amerodectes* Valim and Hernandes 2010, and *Tyrannidectes* Mironov et al. 2008.

Psoroptoididae—Two were identified to the species level: *Mesalgoides piprae* (Berla 1959a, b, c) and *Mesalgoides turdinus* Černý 1974.

Xolalgidae—Represented by the genus *Tucanalges* Gaud and Atyeo 1981 and by individuals of the subfamily Ingrassiinae.

Trouessartidae—The species *Trouessartia serrana* Berla 1959a, b, c, was found.

Falculiferidae—The species *Falculifer leptotilae* Gaud and Barré 1992 was found.

Pterolichidae—Represented by the genus *Lopharalichus* Gaud and Atyeo 1996.

Discussion

A high specificity of feather mites and chewing lice was observed in the riparian areas of Central Brazil. Of the 15 species of chewing lice identified, 4 were associated with only one host species, 3 with only one genus, and 7 were restricted to the family level. However, a generalist species was found, *Menacanthus eurysternus*, which was observed parasitizing 163 species of Passeriformes and Piciformes (Price 1975). Due to the high specificity in these groups, some authors have searched for phylogenetic correlations with their hosts. Some work already suggests that the phylogeny of some groups of chewing lice can clarify the phylogeny of some avian groups (Hopkins 1942; Mey 1999) or that the phylogeny of birds can explain the phylogeny of feather mites because all of the principal lineages

Table 1 Abundance and mean intensity of infestation by louse on birds, between 2008 and 2009, at Palmas, Tocantins, Brazil

Hosts	N	Chewing lice	Abundance					
			Ni	Male	Female	n	T	MI
Columbidae[a]								
Leptotila verreauxi	1	*Physconelloydes ceratoceps*	1	10	6	41	57	57.0
		Columbicola timmermanni[b]	1	20	19	83	122	122.0
		Hohorstiella paladinella[b]	1	3	4	3	10	10.0
Leptotila rufaxilla	2	*Physconelloydes ceratoceps*	2	2	1	1	4	2.0
		Columbicola timmermanni[b]	1	8	6	3	17	17.0
Geotrygon montana	2	*Columbicola macrourae*	1	1	8	10	19	19.0
Psittacidae[c]								
Brotogeris chiriri	1	*Psittacobrosus* sp.	1	1	0	10	11	11.0
Caprimulgidae[d]								
Nyctidromus albicollis	2	*Mulcticola* sp.	1	3	1	2	6	6.0
Momotidae[e]								
Momotus momota	5	*Clayella prionitis*	3	14	39	35	88	29.3
Galbulidae[f]								
Galbula ruficauda	6	*Picicola galbulica*	2	4	6	10	20	10.0
Bucconidae[f]								
Nonnula rubecula	1	*Picicola* sp.	1	0	10	4	14	14.0
		Mayriphilopterus sp.	1	0	1	0	0	1.0
Thamnophilidae[g]								
Thamnophilus punctatus	1	*Tyranniphilopterus* sp.	1	3	4	25	32	32.0
Dysithamnus mentalis	3	*M.achaerilaemus tangarae*[h, b]	1	1	1	2	4	4.0
Furnariidae[g]								
Lochmias nematura	1	*Myrsidea* sp.	1	1	0	0	1	1.0
Dendrocolaptes platyrostris	5	*Rallicola* sp.	3	14	11	28	53	17.7
Tyrannidae[g]								
Leptopogon amaurocephalus	3	*Myrsidea* sp.	1	1	1	6	8	8.0
Tolmomyias flaviventris	2	*Tyranniphilopterus* sp.	1	0	0	2	2	2.0
Platyrinchus mystaceus	1	*Tyranniphilopterus* sp.	1	0	0	1	1	1.0
Lathrotriccus euleri	2	*Tyranniphilopterus* sp.	1	0	8	0	8	8.0
Megarynchus pitangua	1	*Ricinus* sp.	1	0	3	7	10	10.0
		Picicola sp.	1	12	8	8	28	28.0
Pipridae[g]								
Machaeropterus pyrocephalus	5	*Ricinus invadens*[h]	1	0	2	1	3	3.0
Manacus manacus	1	*Ricinus pessimalis*	1	0	2	0	2	2.0
Pipra fasciicauda	15	*Ricinus invadens*	1	0	1	0	1	1.0
Hirundinidae[g]								
Stelgidopterix ruficollis	2	*Myrsidea* sp.	1	0	1	0	1	1.0
Turdidae[g]								
Catharus fuscescens	3	*Myrsidea* sp.	2	10	7	55	72	36.0
		Brueelia sp.	1	1	2	0	3	3.0
Turdus leucomelas	35	*Brueelia* sp.	2	1	4	4	9	4.5
		Myrsidea sp.	9	17	13	67	97	10.7
		Menacanthus eurysternus	1	1	1	0	2	2.0
		Philopterus sp.	1	1	0	0	1	1.0
		Sturnidoecus sp.	2	3	7	26	36	18.0
Thraupidae[g]								
Saltator maximus	7	*Myrsidea lightae*[b]	4	7	5	8	20	5.0

Table 1 (continued)

Hosts	N	Chewing lice	Abundance					
			Ni	Male	Female	n	T	MI
		Philopterus sp.	1	0	0	2	2	2.0
Eucometis penicillata	2	*Myrsidea* sp.	2	5	6	14	25	12.5
		Philopterus sp.	1	2	2	1	5	5.0
Ramphocelus carbo	6	*Myrsidea ramphoceli*[b]	3	3	5	11	19	6.3
Thraupis palmarum	1	*Myrsidea seminuda*	1	1	2	0	3	3.0
Dacnis cayana	3	*Ricinus* sp.	1	3	2	1	6	6.0
Cyanerpes cyaneus	3	*Myrsidea* sp.	1	2	0	0	2	2.0
Emberizidae[g]								
Arremon taciturnus	19	*Myrsidea taciturni*[b]	19	92	72	147	311	16.4
		Sturnidoecus sp.	9	22	69	118	209	23.2
Parulidae[g]								
Basileuterus culicivorus	3	*Ricinus* sp.	1	0	3	1	4	4.0
		Brueelia sp.	1	1	15	32	48	48.0
		Menacanthus aff. dendroicae	1	3	3	15	21	21.0
Basileuterus hypoleucus	4	*Brueelia* sp.	1	0	1	2	3	3.0
Icteridae[g]								
Gnorimopsar chopi	1	*Brueelia* sp.	1	4	4	9	17	17.0
		Myrsidea sp.	1	11	13	12	36	36.0
Total	149		79	288	379	807	1,474	18.7

N number of birds examined, *Ni* number of birds infested, *n* nymph, *T* total, *MI* mean intensity

[a] Columbiformes

[b] New geographic record for Brazil

[c] Psittaciformes

[d] Caprimulgiformes

[e] Coraciformes

[f] Galbuliformes

[g] Passeriformes

[h] New host record

of birds host a particular fauna of these organisms (Černý 1971; Peterson 1975).

Considering that this is the first study conducted on avian ectoparasites in Tocantins (BR), the knowledge about geographical distribution of all chewing lice and feather mites analyzed was expanded. In Brazil, a few studies have information about the association of chewing lice and feather mites with wild birds at the species level (Oniki 1999) and some deal with these ectosymbionts at the level of genus or family (Lyra-Neves et al. 2005).

Chewing lice

The results presented here have expanded the knowledge on the geographical distribution of six species of chewing lice in Brazil: *Columbicola timmermanni*, *H. paladinella*, *Machaerilaemus tangarae*, *Myrsidea lightae*, *Myrsidea ramphoceli*, and *Myrsidea taciturni*. Information regarding the rates of infestation and host–parasite association for each species of chewing lice found in this study were compiled and are discussed separately in the following section.

Menoponidae

Menacanthus eurysternus Generalist species according to Price (1975) is found in 20 families, 70 genera, and 118 species of Passeriformes and 5 species of Piciformes. Recently, Sychra et al. (2007) observed this species parasitizing *Mitrospingus cassini* (Lawrence 1861) in Costa Rica. In Brazil, it was recently observed and is found only on the host *Turdus leucomelas* (Enout et al. 2009). Despite being a generalist, this chewing lice seems to occur less frequently. In this study, only a couple were found on 34 birds checked (prevalence = 3.0 %). Enout et al. (2009) found a prevalence of 11.1 % of these parasites during the reproductive season of birds, whereas during the feather molt, no individuals were found.

Table 2 Prevalence of louse on birds, between 2008 and 2009, at Palmas, Tocantins, Brazil

Hosts	N	Chewing lice	Ni	Prev (%)
Galbula ruficauda	6	*Picicola galbulica*	2	33.3
Dendrocolaptes platyrostris	5	*Rallicola* sp.	3	60.0
Machaeropterus pyrocephalus	5	*Ricinus invadens*	1	20.0
Pipra fasciicauda	15	*Ricinus invadens*	1	6.7
Turdus leucomelas	35	*Brueelia* sp.	2	5.9
		Myrsidea sp.	9	25.7
		Menacanthus eurysternus	1	3.0
		Tyranniphilopterus sp.	1	3.0
		Sturnidoecus sp.	2	6.0
Saltator maximus	7	*Myrsidea lightae*	4	57.1
		Philopterus sp.	1	14.2
Ramphocelus carbo	6	*Myrsidea ramphoceli*	3	50.0
Arremon taciturnus	19	*Myrsidea taciturni*	19	100
		Sturnidoecus sp.	9	47.4

N number of birds examined, *Ni* number of birds infested, *Prev* prevalence

M. aff. dendroicae The typical host of this species is *Dendroica discolor* (Vieillot, 1809) but has also been observed parasitizing *Dendroica coronata* (Linnaeus 1766), in both cases, in the USA (Price 1977). According to Price et al. (2003), only these two hosts were known for this chewing louse. Unlike *Menacanthus eurysternus*, which showed a low mean intensity of infestation (2/bird), the average intensity of infestation on *M. dendroica* was high (21/bird).

M. seminuda This species was collected on its typical host, *Thraupis palmarum*. In Brazil, it had been found in the same host in the state of Mato Grosso do Sul (Sychra et al. 2009). According to Price and Dalgleish (2006), it is also found on *Thraupis episcopus* (Linnaeus 1766) in Costa Rica and in Trinidad and Tobago. Only one host was examined in this study, on which a male and two female lice were found, resulting in a low mean intensity (3/bird).

Myrsidea ramphoceli A species was recently described parasitizing *R. carbo* (Pallas 1764); it was found on the same host in this study. Previously, the species was known only in Peru, Venezuela, and Trinidad and Tobago.

Myrsidea taciturni This species was found on *Arremon taciturnus*. It was recently described from species of Venezuela and is known only on this host; until now, it had only been observed in that country (Price and Dalgleish 2007).

Myrsidea lightae This species was found on the host *Saltator maximus* but is also known to parasitize *Saltator striatipectus* (Lafresnaye 1847). Before this study, its known that geographic distribution was restricted to Panama, Costa Rica, and Venezuela (Price et al. 2008).

H. palladinela According to Hill and Tuff (1978), 18 species are known in this genera, and *H. paladinella* was observed in the USA and northern Mexico on the following hosts: *Leptotila verreauxi*, *Zenaida asiatica* (Linnaeus 1758) and *Zenaida macroura* (Linnaeus 1758). In a recent study, Galloway and Palma (2008) observed this species on *Columba livia* (Gmelin 1789) in Canada, and this study is the first record of it in Brazil.

Machaerilaemus tangarae Until the work of Price et al. 2002, 15 species of Machaerilaemus Harrison 1915 were known, which showed a low prevalence compared to other species of chewing lice collected in the same host. A new species, *Machaerilaemus bonariensis* Chichina 2003, was described recently (Chichina 2003) and the prevalence found was also low. *Machaerilaemus tangarae* had previously been found only in Costa Rica and was known only on the hosts *Tangara larvata* Du Bus de Gisignies 1846 and *Tangara icterocephala* (Bonaparte 1851) (Thraupidae). In this study, it was found on *Dysithamnus mentalis* (Thamnophilidae), presenting an unusual case of association with two host families. This species was only recently described, necessitating more studies to clarify its associations.

Ricinidae

R. pessimalis This species is known to parasitize *Pipra chloromeros* Tschudi 1844 in Bolivia; *Manacus manacus* in Venezuela, Trinidad and Tobago, and Brazil, *Chiroxiphia lanceolata* (Wagler 1830) in Venezuela; *Pipra erythrocephala* (Linnaeus 1758) in Trinidad and Tobago; and *Pipra fasciicauda* in Brazil. The results of Oniki (1999) together with this study strengthen the observation that the species of

Table 3 Prevalence of feather mites on birds, between 2008 and 2009, at Palmas, Tocantins, Brazil

Hosts	N	Feather MITES	Ni	Prev (%)
Columbidae[a]				
Leptotila rufaxilla	2	*Falculifer leptotilae*	1	50.0
Psittacidae[b]				
Brotogeris chiriri	1	*Lopharalichus* sp.	1	100
Caprimulgidae[c]				
Nyctidromus albicollis	2	*Trouessartia* sp.	1	50.0
Momotidae[d]				
Momotus momota	5	Proctophyllodinae	1	20.0
		Analges sp.	1	20.0
Galbulidae[e]				
Galbula ruficauda	6	*Analloptes* sp.	1	16.7
		Pterodectinae	1	16.7
		Mesalgoides sp.	1	16.7
Bucconidae[5]				
M. nigrifrons	3	*Analges* sp.	1	33.3
		Trouessartia sp.	1	33.3
Thamnophilidae[f]				
Thamnophilus punctatus	1	*Amerodectes* sp.	1	100
		Nanopterodectes sp.	1	100
Dysithamnus mentalis	3	*Atrichophyllodes* sp.	1	33.3
Sittasomus griseicapillus	7	*Analges* sp.	2	28.6
		Tyrannidectes sp.	3	42.9
		Platyacarus sittasomi	1	14.3
		Proctophyllodes sp.	2	28.6
		Trouessartia sp.	1	14.3
Dendrocolaptes platyrostris	5	*Platyacarus* sp.	2	40.0
		Tyrannidectes sp.	2	40.0
		Proctophyllodinae	1	20.0
Dendroplex picus	2	Proctophyllodinae	2	100
		Platyacarus sp.	1	50.0
Lepdocolaptes angustirostris	1	*Amerodectes* sp.	1	100
Furnariidae[f]				
Lochmias nematura	1	*Analloptes* sp.	1	100
		Pterodectinae	1	100
		Mesalgoides sp.	1	100
Sittasomus griseicapillus	7	*Analges* sp.	2	28.6
		Tyrannidectes sp.	3	42.9
		Platyacarus sittasomi	1	14.3
		Proctophyllodes sp.	2	28.6
		Trouessartia sp.	1	14.3
Dendrocolaptes platyrostris	5	*Platyacarus* sp.	2	40.0
		Tyrannidectes sp.	2	40.0
		Proctophyllodinae	1	20.0
Dendroplex picus	2	Proctophyllodinae	2	100
		Platyacarus sp.	1	50.0
Lepdocolaptes angustirostris	1	*Amerodectes* sp.	1	100
Tyrannidae[f]				
Myiopagis gaimardii	1	*Amerodectes* sp.	1	100
		Proctophyllodes sp.	1	100
Myiopagis viridicata	1	*Amerodectes* sp.	1	100
		Trouessartia sp.	1	100
Elaenia chiriquensis	2	*Tyrannidectes reticulatus*	1	50.0
		Proctophyllodinae	2	100
Corythopis delalandi	3	*Tyranniphyllodes* sp.	3	100
		Analges sp.	1	33.3
Leptopogon amaurocephalus	3	*Trouessartia* sp.	2	66.7
		Proctophyllodes sp.	3	100
		Analges sp.	1	33.3
Tolmomyias sulphurescens	3	*Tyranniphyllodes* sp.	3	100
Tolmomyias flaviventris	2	Proctophyllodidae	1	50.0
Myiobius atricaudus	3	*Trouessartia* sp.	3	100
		Nycteridocaulus sp.	2	66.7
Lathrotriccus euleri	2	*Amerodectes* sp.	2	100
Pipridae[f]				
Machaeropterus pyrocephalus	5	*Trouessartia* sp.	1	20.0
Manacus manacus	1	*Diproctophyllodes dielytra*	1	100
Antilophia galeata	2	*Diproctophyllodes dielytra*[g]	2	100
Chiroxiphia pareola	1	*Mesalgoides* sp.	1	100
		Amerodectes sp.	1	100
Pipra fasciicauda	15	*Mesalgoides piprae*	1	6.7
		Trouessartia sp.	1	6.7
		Diproctophyllodes dielytra	2	13.3
Hirundinidae[f]				
Stelgidopterix ruficollis	2	*Pteronyssoides* sp.	2	100
		Trouessartia sp.	1	50.0
Troglodytidae[f]				
Pheugopedius genibarbis	4	*Tyrannidectes* sp.	2	50.0
Cantorchilus leucotis	6	*Tyrannidectes* sp.	6	100
Turdidae[f]				
Catharus fuscescens	3	*Amerodectes* sp.	3	100
		Proctophyllodes sp.	3	100
Turdus leucomelas	34	*Amerodectes turdinus*[g]	24	70.6
		Analges sp.	18	52.9
		Trouessartia serrana[g]	19	55.9
		Tyrannidectes amaurochalinus[g]	8	23.5
		Mesalgoides turdinus	3	8.8
Coerebidae[f]				
Coereba flaveola	2	*Amerodectes* sp.	2	100
		Proctophyllodes sp.	2	100
		Analges sp.	1	50.0
Thraupidae[f]				

Table 3 (continued)

Hosts	N	Feather MITES	Ni	Prev (%)
Saltator maximus	7	*Amerodectes* sp.	5	71.4
		Proctophyllodes saltatoris	2	28.6
Eucometis penicillata	2	*Trouessartia* sp.	2	100
		Proctophyllodes sp.	1	50.0
Ramphocelus carbo	6	*Trouessartia* sp.	6	100
		Amerodectes sp.	4	66.7
		Proctophyllodes sp.	2	33.3
Thraupis palmarum	1	*Amerodectes bilineatus*	1	100
		Proctophyllodes sp.	1	100
Tangara cayana	1	*Proctophyllodes* sp.	1	100
		Amerodectes sp.	1	100
Dacnis cayana	3	*Mesalgoides* sp.	1	33.3
		Analges sp.	2	66.7
		Amerodectes sp.	3	100
		Proctophyllodes sp.	1	33.3
Emberizidae[f]				
Arremon taciturnus	19	*Mesalgoides* sp.	13	68.4
		Trouessartia sp.	16	84.2
		Proctophyllodes sp.	15	78.9
Parulidae[f]				
Basileuterus culicivorus	3	*Amerodectes* sp.	1	33.3
		Analges sp.	2	66.7
		Proctophyllodes sp.	2	66.7
Basileuterus hypoleucus	4	*Amerodectes* sp.	4	100
		Trouessartia sp.	1	25.0
		Proctophyllodes sp.	2	50.0
		Analges sp.	1	25.0
Basileuterus flaveolus	5	*Trouessartia* sp.	3	60.0
		Mesalgoides sp.	2	40.0
		Nycteridocaulus sp.	4	80.0
		Amerodectes sp.	3	60.0
		Proctophyllodes sp.	1	20.0

N number of birds examined, *Ni* number of birds infested, *Prev* prevalence

[a] Columbiformes

[b] Psittaciformes

[c] Caprimulgiformes

[d] Coraciformes

[e] Galbuliformes

[f] Passeriformes

[g] New host record

this genus have lower abundance (Nelson 1972). This study found only two individuals on *M. manacus*, and Oniki (1999) found four individuals on *Pipra fasciicauda*.

R. invadens This species was reported to parasitize four species of the Pipridae in the following locations: *Chiroxiphia lanceolata* (Panama), *Macheropterus regulus* (Hahn 1819) (Venezuela), *Pipra erythrocephala* (Panama, Venezuela, and Peru), and *Pipra chloromeros* Tschudi 1844 (no data) (Nelson 1972). Oniki (1999) observed this species on *Pipra fasciicauda* in Brazil, and now *M. pyrocehalus* is recorded as a new host. *R. invadens* were also less abundant, and this study found only three individuals parasitizing *Machaeropterus pyrocephalus*. Oniki (1999) found only three individuals on *Pipra fasciicauda*.

Philopteridae

Clayiella prionitis The genus *Clayella* is found solely on birds of the order Coraciiformes (Mey 2004). The type-host found is *Momotus momota*, the same species of host found in this study. Its geographic distribution is known only for Brazil, without any indication of more specific location (Eichler 1940).

Physconelloydes ceratoceps The genus *Physconelloydes* is found exclusively on Columbiformes (Price et al. 2003) and currently has 16 valid species (Price et al. 1999, 2003). Hill and Tuff (1978) found this species in Bolivia, Colombia, Mexico, Peru, USA, and Trinidad and Tobago, finding it only on *L. verreauxi*. Price et al. (1999) examined material from this species from the following hosts and localities: *L. verreauxi* (Mexico, Trinidad, and Tobago, El Salvador, Guiana, Bolivia, Colombia, and Argentina), *Leptotila rufaxilla* (Guiana), *L. plumbeiceps* Sclater and Salvin 1868 (Mexico), *Leptotila jamaicensis* (Linnaeus 1766) (Mexico), *Leptotila cassini* Lawrence 1867 (Colombia and Costa Rica), and *Geotrygon veraguensis* Lawrence 1867 (no data). In Brazil, the species is already known to parasitize *L. verreauxi*, but only in Mato Grosso (Oniki 1999).

Columbicola macrourae The genus *Columbicola* is found exclusively on Columbiformes (Price et al. 2003). Hill and Tuff (1978) examined specimens coming from the following hosts and localities: *L. verreauxi* (USA), *Z. asiatica* (USA), and *Z. macroura* (Bahamas, Porto Rico, Mexico, and USA). Galloway and Palma (2008) reported this species on *Columba livia* in Canada. Clayton and Price (1999) found new hosts: *Columba plumbea* Vieillot 1818, *Columba subvinacea* (Lawrence 1868), *Zenaida auriculata* (Des Murs 1847), *Zenaida aurita* (Temminck 1809), *Zenaida galapagoensis* Gould 1841, *Geotrygon linearis* (Prevost 1843), *Geotrygon mystacea* (Temminck 1811), *Geotrygon violacea* (Temminck 1809), and *Geotrygon montana*. In the same study, the geographic distribution was also expanded for the following countries: Cuba, Peru, Guiana, Chile, Ecuador, Colombia, Jamaica, and El Salvador. In Brazil, this species was already known to parasitize *G. montana* in Mato Grosso (Oniki 1999).

Columbicola timmermanni This species is known to parasitize *L. rufaxilla, L. verreauxi*, and *L. cassini* from Guiana (Price et al. 2003). In this study, it was found on *L. rufaxilla* and *L. verreauxi* for the first time in Brazil.

Picicola galbulica The genus *Picicola* has 35 valid species (Price et al. 2003; Price and Weckstein 2006; Valim and Linardi 2006) and was reported to parasitize birds of the order Galbuliformes (Bucconidae and Galbulidae), Piciformes (Picidae), and Passeriformes (Dicruridae, Pittidae, Cracticidae, Furnariidae, Tyrannidae, Ptilonorhynchidae, Mimidae, and Parulidae). This species was described in Brazil for *Galbula ruficauda* by Valim and Linardi (2006), of material from the Distrito Federal. Oniki (1999) observed *Picicola* sp. on *G. ruficauda* in Mato Grosso, and despite the fact that the identification was not at the species level, it is probable that the individuals examined are from *Picicola galbulica*. In Oniki (1999), the mean intensity of infestation was high (30/bird), much higher than this study (10/bird).

Feather mites

The feather mites are part of a very diverse and abundant group of the avian ectosymbiontes and are not relatively well known (Gaud and Atyeo 1996). In Brazil, studies about the host–parasite relations, to the level of genus or family, were already conducted in a few localities (Lyra-Neves et al. 2000, 2005; Roda and Farias 1999b; Kanegae et al. 2008), and recently, the knowledge to the species level has increased with taxonomic studies (Hernandes and Valim 2005, 2006; Hernandes et al. 2007; Mironov et al. 2008; Valim and Hernandes 2008, 2010).

This study identified 11 species and 16 genera of feather mites. In a recent study conducted in the Distrito Federal, Central Brazil, located in the Cerrado biome, Kanegae et al. (2008) identified 12 species and 22 genera; however, no species identified by these authors coincide with the ones found in Tocantins, showing both the high diversity of this group and the limited knowledge about it.

Proctophyllodidae

This is the family with the highest prevalence (43.6 %), as in Kanegae et al. (2008) in the Cerrado of the Distrito Federal (30 %). In Pernambuco, Roda and Farias (1999b) reported that this family showed the highest number of hosts between the bird species analyzed. The list of hosts includes nine genera, with *Amerodectes* Valim and Hernandes 2010 (as *Pterodectes s.l.*), having the highest prevalence (33.3 %). Kanegae et al. (2008) also observed the highest prevalence for *Pterodectes s.l.* (19.6 %). This is one of the more abundant and diverse groups of feather mites, often being quoted in studies conducted in Brazil (Lyra-Neves et al. 2003; Storni et al. 2005), where they are found exclusively on Passeriformes (Valim and Hernandes 2010).

Hosts of the genus *Turdus* Linnaeus 1758 are frequently found with mites of the subfamily Pterodectinae. *Tyrannidectes amaurochalinus* was recently reported in *Turdus amaurochalinus* Cabanis 1850. *Amerodectes turdinus* has as its type-host *Turdus rufiventris* Vieillot 1818 and was recently found on *Turdus albicollis* Vieillot 1818, in Rio de Janeiro (Storni et al. 2005). In this study, both *Amerodectes turdinus* and *Tyrannidectes amaurochalinus* were found on *Turdus leucomelas*, adding a new host species for both species of mites. Recently, the species *Tyrannidectes fissuratus* Hernandes and Valim 2005 was described with material from *Turdus leucomelas*, thus making this bird species a host of three species of Pterodectinae, indicating the high specialization of these mites in microhabitats (Gaud and Atyeo 1996).

A species of a monotypic genus recently described in the subfamily Pterodectinae was found, *Nanopterodectes* Mironov 2008 (Mironov et al. 2008; Mironov 2009). *Nanopterodectes formicivora* Mironov 2008 has as type-host *Formicivora rufa* (Wied-Neuwied 1831) and was described with material from Mato Grosso do Sul, Brazil. In Tocantins, *Nanopterodectes* sp. was found on *Thamnophilus punctatus*.

Another genus with high prevalence in the family Proctophyllodidae was *Proctophyllodes* Robin 1868. Found on 14 host species, it was the third most prevalent genus (23.5 %) after *Amerodectes* and *Trouessartia*. It is found on Passeriformes and Apodiformes, and recently, Kanegae et al. (2008) reported a new host for the first order and two new hosts for the second order. Despite being found on 20 families of Passeriformes birds (Atyeo and Braasch 1966), this study observed it for the first time on Parulidae and Dendrocolaptidae. One species was identified in this genus, *P. saltatoris*, observed for the first time in Brazil on its type-host, *S. maximus*.

Of the hosts of *Diproctophyllodes dielytra*, *Antilophia galeata* represents a new record, even if Kanegae et al. (2008) had recorded *Diproctophyllodes* sp. on *Antilophia galeata* in the Distrito Federal, without identification to the species level.

Another genus of this family found on the birds of Tocantins was *Platyacarus* Kudon 1982, a taxon restricted to the family Dendrocolaptidae and found in 17 bird species (Kudon 1985; Hernandes et al. 2007). The species found in this study, *Platyacarus sittasomi*, was described recently on *Sittasomus griseicapillus*, the same host found in this study. *Platyacarus* sp. was also found on *Dendrocolaptes platyrostris* and *Dendroplex picus*.

Atrichophyllodes was recently described and has two species, *Atrichophyllodes delalandi* Hernandes, Valim, and Mironov 2007 on *Corythopis delalandi* and *Atrichophyllodes mentalis* Hernandes, Valim, and Mironov 2007 on

Dysithamnus mentalis. In this study, it was found on *Thamnophilus punctatus*, though the mite found in Tocantins seems to be a new species, distinct from the others in this genus.

Nycteridocaulus genus was found on *Myiobius atricaudus* and *Basileuterus flaveolus*. The species could not be identified but had observable differences and thus probably represents two distinct species. The work of Kanegae et al. (2008) increased knowledge about the distribution of three species of this genus for Brazil with their findings in the Distrito Federal, and *Nycteridocaulus tyranni* Atyeo 1966 was observed in *B. flaveolus*. Nevertheless, the specimen found in Tocantins differs significantly from this one.

Trouessartiidae

This species was the second most prevalent family (28.9 %), and this result matches the one in Kanegae et al. (2008) (17.21 %). The species *Trouessartia serrana* was found on *Turdus leucomelas*, thus registering a new host because this mite was known previously only on *Turdus albicollis* (Santana 1976). In this study, another 14 bird species were found hosting *Trouessartia* sp. Other studies in Brazil also frequently found these mites. Kanegae et al. (2008) found 34 hosts in the Cerrado of the Distrito Federal; in the Mata Atlântica, in Pernambuco, Roda and Farias (1999b) found 16 hosts, and Lyra-Neves et al. (2003) found another 9 hosts of this feather mite on Passeriformes. Considering that each one of these studies was conducted with different bird communities and in different locations, it is possible to predict that the diversity of this genus is very high and that there needs to be more taxonomic studies to describe and identify the new species.

Analgidae

The family Analgidae was represented only by *Analges* sp., but none of the species could be identified. In this study, these mites were found on 10 hosts divided in eight bird families. Kanegae et al. (2008) previously found this taxon only on seven species between the 83 inspected in their study, and Roda and Farias (1999b) found low prevalence (7.6 %) in Pernambuco. However, no species of this genus were identified in Brazilian wild birds. This illustrates the low level of knowledge about this group.

Psoroptoididae

The family Psoroptoididae was represented by mites of the genus *Mesalgoides*, and two species could be identified, *Mesalgoides piprae* and *Mesalgoides turdinus*. The first was already known in Brazil, being described with material from Pernambuco, but the host found in Tocantins, *Pipra fasciicauda*, is a new record. In the case of *Mesalgoides turdinus*, it has as type-host the species *Turdus leucomelas*, the same found in this study. This mite was not previously known in Brazilian wild birds, and with this finding, the knowledge about its geographic distribution is expanded.

Many taxa could not be identified to the species level because there is no description for them. Many of the species identified are composed of new records for Brazil or new host records. Therefore, we conclude that it is very important to expand on the taxonomic studies for these organisms.

Acknowledgments Many thanks for the big help of Michel P. Valim (Parasitological Department, Federal University of Minas Gerais—UFMG), whose participation in different steps of this project, including the identification of all parasites, was fundamental to its conclusion. Thanks to the Laboratory of Ectoparasitology and the Laboratory of Ecology of Insects of UFMG for permitting the use of its installations and to my friend Andrey J. de Andrade for his help. The logistic support offered by Professor Renato Torres and Maria Amélia (Ecotropical Institute) in Tocantins was critical to the completion of this project.

Funding This research was supported by Fundação de Amparo à Pesquisa de Minas Gerais (FAPEMIG), Brazil. CNPq provides a scholarship to Antonini, Y.

Conflict of interest The authors have no conflicts of interest concerning the work reported in this paper.

References

Alitzer S, Harvell D, Friedle E (2003) Rapid evolutionary dynamics and disease threats to biodiversity. Trends Ecol Evol 18:589–596

Atyeo WT, Braasch NL (1966) The feather mite genus *Proctophyllodes* (Sarcoptiformes: Proctophyllodidae). B U Nebraska State Museum 5:1–354

Berla HF (1958) Analgesidae Neotropicais I. Duas novas espécies de *Pterodectes* Robin, 1868 (Acarina, Proctophyllodinae) coletadas em Fringillidae, Aves, Passeriformes. Bol Mus Nac Rio de Janeiro, *n.s*. Zoologia 186:1–6

Berla HF (1959a) Analgesoidea Neotropicais IV. Sôbre algumas espécies novas ou pouco conhecidas de acarinos plumícolas. Bol Mus Nac Rio de Janeiro, *n.s*. Zoologia 209:1–17

Berla HF (1959b) Analgesoidea Neotropicais V. Sôbre uma espécie nova de "*Proctophyllodes*" Robin, 1868 e redescrição de "*Pterolichus varians selenurus*" Trouessart, 1898 (Acarina, Pterolichinae). Rev Bras Biol 19:203–206

Berla HF (1959c) Analgesoidea Neotropicais VI. Um novo gênero de acarinos plumícolas (Acarina, Proctophyllodinae), hóspede de Oxyruncidae (Aves, Passeriformes). Stud Entomol 2:31–32

Berla HF (1960) Analgesoidea Neotropicais VII. Novas espécies de acarinos plumícolas. An Acad Bras Cienc 32:95–105

Blanco G, Tella JL, Potti J (1997) Feather mites on group-living red-billed choughs: a non-parasitic interaction? J Avian Biol 28:197–206

Blanco G, Tella JL, Potti J, Baz A (2001) Feather mites on birds: costs of parasitism or conditional outcomes? J Avian Biol 32:271–274

Bush AO, Lafferty KD, Lotz JM, Shostak AW (1997) Parasitology meets ecology on its own terms: Margolis et al. revisited. J Parasitol 83 (4):575–583

Carvalho AR, Serra-Freire NM (2001) Identificação de ácaros Astigmata encontrados em penas de pipira-do-papo-vermelho (*Ramphocelus carbo*) em Belém, Pará, Brasil. Tangara 1(2):85–87

Černý V (1971) Parasite–host relationships in feather mites. In: Daniel M, Rosicky B (eds) Proceedings of the third international congress on acarology. Czec Acad Sci Prague, pp 761–764

Clayton DH, Drown DM (2001) Critical evaluation of five methods for quantifying chewing lice (Insecta: Phthiraptera). J Parasitol 87 (6):1291–1300

Clayton DH, Price RD (1999) Taxonomy of New World *Columbicola* (Phthiraptera: Philopteridae) from the Columbiformes (Ave), with descriptions of five new species. Ann Entomol Soc Am 92(5):675–685

Clayton DH, Tompkins DM (1995) Comparative effects of mites and lice on the reproductive success of rock doves (*Columba livia*). Parasitology 110:195–206

Clayton DH, Gregory RD, Price RD (1992) Comparative ecology of Neotropical bird lice (Insecta: Phithiraptera). J Anim Ecol 61:781–795

Dabert J, Mironov SV (1999) Origin and evolution of feather mites (Astigmata). Exp Appl Acarol 23:437–454

Eichler W (1940) Notulae Mallophagologicae IV. Zool Anz 5/6

Eiten G (1972) The Cerrado vegetation of Brazil. Bot Rev 38:201–341

Enout AMJ, Lobato DN, Azevedo CS, Antonini Y (2009) Parasitismo por malófagos (Insecta) e ácaros (Acari) em *Turdus leucomelas* (Aves) nas estações reprodutiva e de muda de penas no Parque Estadual do Rio Preto, Minas Gerais, Brasil. Zoologia 26(3):534–540

Flechtmann CHW (1990) Ácaros de importância médico veterinária. Nobel, São Paulo, p 193

Galloway TD, Palma RL (2008) Serendipity with chewing lice (Phthiraptera: Menoponidae, Philopteridae) infesting rock pigeons and mourning doves (Aves: Columbiformes: Columbidae) in Manitoba, with new records for North America and Canada. Can Entomol 140:208–218

Gaud J, Atyeo WT (1996) Feather mites of the world (Acarina, Astigmata): the supraspecific taxa. Part I. Ann Mus Roy Afr Cent Sci Zool 277:3–193

Guimarães LR (1936) Contribuições para o conhecimento das Mallophagas das aves do Brasil. IV – Dois novos gêneros e uma nova espécie da família Philopteridae. Rev Mus Univ São Paulo 20:221–228

Guimarães LR (1945) Sobre alguns ectoparasitos de aves e mamíferos do litoral paranaense. Arq Mus Paranaense, Curitiba 4:179–190

Hernandes FA, Valim MP (2005) A new species of *Pterodectes* Robin, 1877 (Proctophyllodidae: Pterodectinae) from the pale-breasted thrush, *Turdus leucomelas* (Passeriformes: Turdidae). Zootaxa 1081:61–68

Hernandes FA, Valim MP (2006) Two new species of the feather mite subfamily Pterodectinae (Acari: Astigmata: Proctophyllodidae) from Brazil. Zootaxa 1235:49–61

Hernandes FA, Valim MP, Mironov SV (2007) Two new genera and five new species of the feather mite subfamily Proctophyllodinae (Astigmata: Proctophyllodidae) from suboscine birds in Brazil. J Nat Hist 41:2653–2681

Hill W, Tuff D (1978) A review of the Mallophaga parasitizing the Columbiformes of North America north of Mexico. J Kansas Entomol Soc 51(2):307–327

Hopkins GHE (1942) The Mallophaga as an aid to the classification of birds. Ibis 84:94–106

Johnson KP, Clayton DH (2003) The biology, ecology and evolution of chewing lice, pp 449–476. In: Price RD, Hellemhal RA, Palma RL, Johnson KP, Clayton DH (eds) The chewing lice: word checklist and biological overview. Illinois Natural History Survey Special Publication, 24, XX+501p

Kanegae MF, Valim MP, Fonseca MA (2008) Ácaros plumícolas (Acari: Astigmata) em aves do Cerrado do Distrito Federal, Brasil. Biota Neotrop 8(1):31–39

Klink CA, Machado RB (2005) Conservation of the Brazilian Cerrado. Conserv Biol 19(3):707–713

Kudon LH (1985) Host relationships of the feather mite genus *Platyacarus* Kudon (Acarina: Proctophyllodidae) with a key to the species. J Georgia Entomol Soc 17(4):545–552

Lyra-Neves RM, Farias AMI, Júnior WRT, Botelho MCN, Lima MCA (2000) Ectoparasitismo em aves silvestres (Passeriformes - Emberizidae) de Mata Atlântica, Igarassu, Pernambuco. Melopsittacus 3 (2):64–71

Lyra-Neves RM, Farias AMI, Telino-Júnior WR (2003) Ecological relationships between feather mites (Acari) and wild birds of Emberizidae (Aves) in a fragment of Atlantic Forest in northeastern Brazil. Rev Bras Zool 20(3):481–485

Lyra-Neves RM, Farias AMI, Júnior WRT (2005) Interações entre Phithiraptera (Insecta) e aves (Emberizidae) de Mata Atlântica, Pernambuco, Brasil. Ornithologia 1(1):43–47

Marini MÂ, Couto D (1997) Correlações ecológicas entre ectoparasitos e aves de floresta de Minas Gerais. In: Leite LL, Saito CH (eds) Contribuição ao Conhecimento Ecológico do Cerrado. Departamento de Ecologia, Universidade de Brasília, pp 210–218

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

Marshall AG (1981) The ecology of ectoparasitic insects. Academic, New York

Mey E (1999) Phylogenetic relationships of the Megapodiidae as indicated by their ischnoceran, in particular goniodid, chewing lice (Insecta: Phthiraptera). Zool Verhand Leid 327:23–35

Mey E (2004) Zur Taxoniomie, Verbreitung und parasitophyletische Evidenz des Philoterus-Komplexes (Insecta, Phithiraptera, Ischnocera). Ornithol Anz 43:149–203

Mironov SV (2009) Phylogeny of feather mites of the subfamily Pterodectinae (Acariformes: Proctophyllodidae) and their host associations with passerines (Passeriformes). Proc Zool Inst 313(2):97–118

Mironov SV, Literak I, Čapek M (2008) New feather mites of the subfamily Pterodectinae (Acari: Astigmata: Proctophyllodidae) from passerines (Aves: Passeriformes) in Mato Grosso do Sul, Brazil. Zootaxa 1947:1–38

Nelson BC (1972) A revision of the New World species of *Ricinus* (Mallophaga) occurring in Passeriformes (Aves). Univ Calif Publ Entomol 68:1–175

Oniki Y (1999) Avian parasites and notes on habits of lice from Mato Grosso, Brazil. Iheringia Sér Zoologia 86:183–190

Oniki Y (2000) *Ricinus bluteri* n. sp. (Insecta, Phithiraptera, Amblycera, Ricinidae) from the Rufous-capped Spinetail *Synallaxis ruficapilla* (Aves, Passeriformes, Furnariidae). Rud Natur Schri 10:53–58

Oniki Y (2004) *Ricinus bluteri* n. sp. (Insecta, Phithiraptera, Amblycera, Ricinidae)—a second *Ricinus* species on the Rufous-capped spinetail *Synallaxis ruficapilla* (Aves, Passeriformes, Furnariidae). Rud Natur Schri 12:129–132

Oniki Y, Willis EO (1993) Pesos, medidas, mudas, temperaturas cloacais e ectoparasitos de aves da reserva ecológica do Panga, Minas Gerais, Brasil. Boletim CEO nº9

Palma RL (1978) Slide-mounting of lice: a detailed description of the Canada Balsam technique. New Zeal Entomol 6:432–436

Peterson PC (1975) An analysis of host-parasite associations among feather mites (Acari: Analgoidea). Misc Publ Entomol Soc Am 9:237–242

Price RD (1975) The *Menacanthus eurysternus* complex (Mallophaga: Menoponidae) of the Passeriformes and Piciformes (Aves). Ann Entomol Soc Am 68(4):617–622

Price RD (1977) The *Menacanthus* (Mallophaga: Menoponidae) of the Passeriformes (Aves). J Med Entomol 14(2):207–220

Price RD, Dalgleish RC (2006) *Myrsidea* Waterston (Phthiraptera: Menoponidae) from tanagers (Passeriformes: Thraupidae), with descriptions of 18 new species. Zootaxa 1174:1–25

Price RD, Dalgleish RC (2007) *Myrsidea* Waterston (Phthiraptera: Menoponidae) from the Emberizidae (Passeriformes), with descriptions of 13 new species. Zootaxa 1467:1–18

Price RD, Weckstein JD (2006) *Picicola* Clay and Meinertzhagen (Phthiraptera: Philopteridae) from jacamars and puffbirds (Piciformes: Galbulidae, Bucconidae), with descriptions of five new species. Zootaxa 1367:37–50

Price RD, Clayton DH, Hellenthal RA (1999) Taxonomic review of *Physconelloides* (Phthiraptera: Philopteridae) from the Columbiformes (Aves), including descriptions of three new species. J Med Entomol 36(2):195–206

Price RD, Hellenthal RA, Dalgleish RC (2002) A review of *Machaerilaemus* (Phthiraptera: Amblycera: Menoponidae) from the Passeriformes (Aves), with the description of five new species. Am Midl Nat 148:61–74

Price RD, Hellenthal RA, Palma RL, Johnson KP, Clayton DH (2003) The chewing lice: world checklist and biological overview. Ill Nat Hist Surv Spec Publ 24:501p

Price RD, Johnson KP, Dalgleish RC (2008) Five new species of *Myrsidea* Waterston (Phthiraptera: Menoponidae) from saltators and grosbeaks (Passeriformes: Cardinalidae). Zootaxa 1873:1–10

Proctor HC (2003) Feather mites (Acari: Astigmata): ecology, behavior, and evolution. Annu Rev Entomol 48:185–209

Remsen JV, Cadena CD, Jaramillo A, Nores M, Pacheco JF, Pérez-Emán J, Robbins MB, Stiles FG, Stotz DF, Zimmer KJ (Version 08 August 2011). A classification of the bird species of South America. AOU. Avaliable from: http://www.museum.lsu.edu/~Remsen/SACCBaseline.html

Ribeiro JFE, Walter BMT (1998) Fitofisionomia do bioma do Cerrado. In: Sano SM & Almeida SP (eds) Ambiente e Flora. Planaltina - DF - EMBRAPA, Cerrado. p 556

Roda SA, Farias AMI (1999a) Aves silvestres infestadas por Phthiraptera (Insecta) na Zona da mata Norte de Pernambuco, Brasil. Rev Bras Zool 16(3):871–878

Roda SA, Farias AMI (1999b) Ácaros plumícolas em aves Passeriformes da Zona da Mata Norte de Pernambuco, Brasil. Rev Bras Zool 16(3):879–886

Roda SA, Farias AMI (2007) Ácaros plumícolas em beija-flores no município de Vicência, Pernambuco, Brasil. Lundiana 8(1):13–16

Santana FJ (1976) A review of the genus *Trouessartia*. J Med Entomol suppl. 1:1–128

Storni A, Alves MAS, Valim MP (2005) Ácaros de penas e carrapatos (Acari) associados a *Turdus albicollis* Vieillot (Aves: Muscicapidae) em uma área de Mata Atlântica da Ilha Grande, Rio de Janeiro. Rev Bras Zool 22(2):419–423

Sychra O, Literák I, Kapek M, Havlicek M (2007) Chewing lice (Phthiraptera) from buntings, cardinals and tanagers (Passeriformes: Emberizidae, Cardinalidae, Thraupidae) from Costa Rica, with descriptions of two new species of the genus *Myrsidea* (Phthiraptera: Menoponidae). Zootaxa 1631:57–68

Sychra O, Literak I, Capek M (2009) Chewing Lice of the Genus Myrsidea Waterston (Phthiraptera: Menoponidae) from the Emberizidae and Thraupidae (Passeriformes) in Mato Grosso do Sul, Brazil. Neotrop. Entomol 38:501–503

Valim MP, Hernandes FA (2006) Redescriptions of four species of the feather mite genus *Pterodectes* Robin, 1877 (Acari: Proctophyllodidae: Pterodectinae) described by Herbert F. Berla. Acarina 14:41–55

Valim MP, Hernandes FA (2008) Redescriptions of five species of the feather mite genus *Pterodectes* Robin, 1877 (Acari: Proctophyllodidae: Pterodectinae) with the proposal of a new genus and a new species. Acarina 16(2):131–157

Valim MP, Hernandes FA (2010) A systematic review of feather mites of the *Pterodectes* generic complex (Acari: Proctophyllodidae: Pterodectinae) with redescriptions of species described by Vladimír Černý. Acarina 18(1):3–35

Valim MP, Linardi PM (2006) Two new species of Picicola Clay and Meinertzhagen, 1938 (Phthiraptera: Philopteridae) from Piciformes (Bucconidae and Galbulidae) in Brazil. Zootaxa 1172:21–29

Valim MP, Hernandes FA, Proctor HC (2011) Feather mites of Brazil (Acari: Astigmata: Analgoidea and Pterolichoidea). Int J Acarol 37(4):293–324

Walther BA, Clayton DH (1997) Dust-ruffling: a simple method for quantifying ectoparasite loads of live birds. J Field Ornithol 68:509–518