Parasitol Res (2013) 112:621–628
DOI 10.1007/s00436-012-3174-5

ORIGINAL PAPER

Community of arthropod ectoparasites of two species of *Turdus* Linnaeus, 1758 (Passeriformes: Turdidae) in southern Rio Grande do Sul, Brazil

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Received: 18 July 2011 / Accepted: 11 October 2012 / Published online: 24 October 2012

Abstract This study was aimed at describing the community of arthropod ectoparasites associated with sympatric populations of *Turdus amaurochalinus* and *Turdus rufiventris* and analyzing the aggregation patterns of the chewing lice species, during reproductive and nonreproductive periods, of both *Turdus* species in three areas of the Atlantic forest in southern Rio Grande do Sul state (RS), Brazil. Altogether, we captured 36 specimens of *T. amaurochalinus* and 53 specimens of *T. rufiventris*. We identified two families of chewing lice, Menoponidae and Philopteridae, with *Myrsidea* and *Brueelia* as the most prevalent and abundant on both host birds. The lowest aggregation levels of chewing lice *Myrsidea* and *Brueelia* occurred during the reproductive period of both host species, suggesting a reproductive synchronization and a dispersion period. The most prevalent feather mite on *T. amaurochalinus* was *Proctophyllodes weigoldi*, and on *T. rufiventris*, *Trouessartia serrana*. *Analges* sp. and *Pteronyssoides* sp. were not observed on *T. rufiventris*. We identified three species of ticks; *Ixodes auritulus* was the most prevalent and abundant on the birds. *Ornithoica vicina* was the only hippoboscid fly collected, and only on *T. amaurochalinus*. The richness of ectoparasites was greater on *T. amaurochalinus* than on *T. rufiventris*. For *T. amaurochalinus*, the mean richness was lesser in winter compared to spring and autumn; however, we observed no variation in the mean richness of ectoparasites for *T. rufiventris* during the same seasons.

Introduction

Parasitism, similar to predation and competition, is an important selective force on populations, as it reduces the resources directed to physiological processes of hosts (Loye and Carrol 1995; Sorci et al. 1996). Parasites can influence the temporal and spatial dynamics of host populations (Hale and Briskie 2009) and the structure of communities (Holmes and Price 1986), as infected individuals have a reduced fitness and can become more susceptible to predation (Anderson and May 1979).

Ectoparasitism in birds is determined by several factors, including biological (susceptibility) and ecological ones

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(social, reproductive, and foraging behaviors) (Begon et al. 1990; Marini et al. 1996; Heeb et al. 2000), associated with parasites as well as hosts. Some physical factors, such as temperature and rainfall, have been suggested to explain seasonal differences in intensity, abundance, and prevalence of parasites (Linardi et al. 1985; Davidson et al. 1994; Moyer et al. 2002). Such associations can be driven either by synchronization of reproduction or dispersal of ectoparasites with life history stages of their hosts (Blanco and Frías 2001; Altizer et al. 2004).

In Brazil, the reproduction season for most bird species occurs between September and January (Sick 1997). During reproductive season, more interaction between host individuals is expected, probably increasing the rates of transmission of ectoparasites, mainly those which are transmitted by direct contact, such as chewing lice (Marshall 1981) and feather mites (Gaud and Atyeo 1996), diminishing the aggregation levels. On the other hand, lower interaction between host individuals is expected during the nonreproductive period, resulting in a high aggregation of ectoparasites.

In birds, the feathers create a complex environment that allows the occurrence of many groups of arthropod ectoparasites (Janovy 1997). Feather mites (Acari: Astigmata) and chewing lice (Phthiraptera: Amblycera and Ischnocera) are the most frequently observed (Marshall 1981).

Although Brazil has one of the richest avifaunas in the world with 1,832 species, of which thirteen belong to the genus *Turdus* (CBRO 2011), few studies have focused on their community of arthropod ectoparasites. Only the ectoparasites of *Turdus albicollis* Vieillot, 1818 and *Turdus leucomelas* Vieillot, 1818 have been studied in Brazil, and further studies are needed. Here, we examined the ectoparasites of *Turdus amaurochalinus* Cabanis, 1850 and *Turdus rufiventris* Vieillot, 1818. Both species have a geographic distribution restricted to South America and are frequently found in forest edges (Sick 1997). According to Belton (2004), they are omnivores, with a preference for fruits, but can also feed on insects captured while foraging on the ground. Despite their abundance in most of Brazil (Sick 1997), no studies on their ectoparasites have been conducted.

The present study was aimed at describing the community of arthropod ectoparasites associated with sympatric populations of *T. amaurochalinus* and *T. rufiventris* in three areas of Atlantic Forest, southern Rio Grande do Sul state. We conducted a qualitative survey of feather mites and quali–quantitiative survey of chewing lice, ticks, and hippoboscid flies of each host species and examined the effect of seasonality on the abundance and richness of ectoparasites on both species of *Turdus*. Therefore, we considered also that the chewing lice species are less aggregated during spring and summer (reproductive season) and more aggregated during autumn and winter (nonreproductive season).

Material and methods

The study was carried out in three areas of Atlantic Forest in the rural area of the municipality of Pelotas, Rio Grande do Sul state: Estação Experimental Cascata—Embrapa Clima Temperado (31°37′ S; 52°31′ W), Hotel Bachini (31°31′ S; 52°28′ W), and Sítio Araçá (31°39′ S; 52°31′ W).

The three areas are located in the physiographic region termed “Serra do Sudeste” or “Serra dos Tapes”. The Serra do Sudeste occupies approximately 44,000 km^2 with physiognomically distinct habitats, altitudes ranging from 200 to 500 m, and relief with wide topographic differences (Rambo 1994).

According to Veloso and Góes-Filho (1982) and Teixeira et al. (1986), the vegetation of this ecosystem is associated with the Atlantic Forest Biome termed Seasonal Semideciduous Forest.

The climate is humid subtropical, Cfa (humid temperate climate with hot summer) according to the classification of Köppen (Moreno 1961). The annual average temperature of the urban area of the municipality is 17.8 °C. January is the hottest month, with an average temperature of 23.2 °C, and July the coldest, with average temperature of 12.3 °C. The annual average precipitation is 1,369 mm, and the rainfall is distributed evenly throughout the year (Embrapa (Estação Agroclimatológica de Pelotas - Capão do Leão) com convênio UFPel e INMET.: http://www.cpact.embrapa.br/agromet/estacao/normais.html).

From July 2009 to June 2010, birds were captured during four field trips per area, one in each season. Once a month, from 0600–0700 until 1730–1830 hours, four mist nets (12 m×2.5 m) were set up in forest edges, totaling 144 h/net of sampling. Each captured bird was placed in an individual cotton bag until the collection of ectoparasites, which was performed according to the method of dust-ruffling (Walther and Clayton 1997); however, with another pyrethroid. Birds were dusted with a pyrethroid which consisted of 0.25 g permethrin, 2.5 g precipitated sulfur, and excipient q.s.p. 100.0 g (Piolhaves®, ProvetS Simões Laboratório Ltda.) for 10 min to irritate their ectoparasites, which were then dislodged from the plumage by ruffling the feathers for 1 min, over a collecting surface. Permethrin is a common synthetic chemical, widely used as an insecticide, acaricide, which belongs to the family of pyrethroids and has low toxicity to birds. Permethrin acts on the nervous system of insects. It interferes with sodium channels to disrupt the function of neurons, and causes muscles to spasm, culminating in paralysis and death (Tomlin 2006). Precipitated sulfur is commonly used for controlling fungi that attack plants but also has acaricidal action (Kidd and James 1991).

To avoid contamination of samples, especially among birds of different species, the cotton bags and the materials used to remove ectoparasites, such as brushes and tweezers, were separated and washed after use. The surface to collect ectoparasites, consisted of a 50 cm×30 cm sheet of tissue paper, placed under each captured specimen, being discarded after use. To maintain the independence of samples, ectoparasites of each bird were sampled only at the first capture. After the collection of the material, birds were banded with metal rings (provided by CEMAVE/IBAMA) and released near the site of capture.

Engorged larvae or nymph of ticks (Acari: Ixodidae), mainly found in the neck of birds and around the eyes and beak, were collected manually and with the aid of tweezers, before application of pyrethroid. However, due to the small body size, same ticks, mainly not engorged specimens, were collected after application of pyrethroid.

The ectoparasites of each captured bird were placed in containers filled with 70 % ethanol. Identification was carried out at the Laboratory of Biology of Insects of the Institute of Biology of the Universidade Federal de Pelotas (UFPel).

The identification of feather mites was carried out after lactophenol clearing, mounted on slides with Hoyer's medium and identified at the suprageneric level according to Gaud and Atyeo (1996), and Atyeo and Braasch (1966), Černý (1974), Santana (1976), Hernandes and Valim (2005), and Valim and Hernandes (2006) for specific categories. Ticks were identified according to Clifford et al. (1973), Durden and Keirans (1996), Keirans and Durden (1998), Onofrio et al. (2009), and Martins et al. (2010). Chewing lice were mounted in permanent slides according to Palma (1978) and identified following Price (1975), Castro and Cicchino (1978), Cicchino (1985), and Price et al. (2003). Hippoboscid flies were identified according to Graciolli and Carvalho (2003).

The terms infrapopulations and infracommunity, as well as the results of prevalence and average intensity of infestation of arthropod ectoparasites of each host species were used following Bush et al. (1997). The effect of seasonality on the average intensity of infestation and the species richness of ectoparasites on both species of *Turdus* was examined using general linear models with Poisson or quasipoisson distribution to correct for overdispersion (Crawley 2007). Nonsignificant results were excluded from the model, and the significance was tested as suggested by Crawley (2007). Significance level was $P<0.05$. Analyses were performed with the statistical program R (R Development Team 2009). Using the software Quantitative Parasitology 3.0 (Reiczigel and Rózsa 2005) the aggregation of chewing lice on host species was analyzed based on the parameter *k* of the negative binomial distribution.

Results

We captured a total of 36 specimens of *T. amaurochalinus* and 53 of *T. rufiventris*. Two families of chewing lice were collected and identified: Menoponidae and Philopteridae. In *T. amaurochalinus*, *Myrsidea* sp., *Menacanthus eurysternus* Burmeister, 1838 (Menoponidae) and *Brueelia* sp. and *Philopterus* sp. (Philopteridae) were observed. In *T. rufiventris*, *Myrsidea* sp., *M. eurysternus*, and *Brueelia addoloratoi* Cicchino 1985 were found.

In the winter, spring, and autumn, *Myrsidea* sp. was the most prevalent parasite on *T. amaurochalinus* and *T. rufiventris* (Table 1). *Brueelia* sp. and *Philopterus* sp. were found only on *T. amaurochalinus* and were less abundant in the winter, spring, and autumn. *B. addoloratoi* also occurred in these seasons, but exclusively on *T. rufiventris* and was more prevalent in the spring. *M. eurysternus* was less common in the winter and autumn on *T. amaurochalinus,* and in the spring on *T. rufiventris* (Table 1).

Myrsidea sp. was the most abundant species in the winter, spring, and autumn in *T. amaurochalinus* and *T. rufiventris.* Although variations were observed in the levels of average intensity of infestation of all species of chewing lice on both species of *Turdus*, these differences were not significant throughout the seasons (X^2=2,139.6; *df*=3;80; $P<0.3$). On both host species, *M. eurysternus* was the less abundant (Table 1).

In the summer, only one specimen was captured, and therefore the data obtained in this season were excluded from the statistical analysis, as they could influence the results.

Chewing lice were most abundant on both species of *Turdus* in the autumn (n=1416), followed by spring (n=1,091), winter (n=789) and summer (n=23). Of these, 92.9 % were collected on *T. rufiventris*. Winter and spring were the seasons in which we observed the largest (*T. amaurochalinus*, k=0.5; *T. rufiventris*, k=0.75) and the lowest (*T. amaurochalinus*, k=0.91; *T. rufiventris*, k=1.8) values of the aggregation of all chewing lice species analyzed together, as well as for the *Myrsidea* sp. over both host species. Over the *T. rufiventris, B. addoloratoi* also presented the lowest rate of aggregation in the spring season; however, the largest values of the aggregation occurred in the autumn (Table 1).

Of the 36 specimens of *T. amaurochalinus*, 55.5 % had only one species of chewing louse, 5.6 % two, and only 2.8 % three species. In *T. rufiventris*, 43.4 % of the birds had one species, while 52.8 %, two (Fig. 1). The average richness of species of chewing lice per host on *T. amaurochalinus* was lower (average=1.1; SD=± 0.49) than that on *T. rufiventris* (average=1.5; SD=± 0.5).

On *T. amaurochalinus* and *T. rufiventris,* only feather mites of the order Astigmata were found: *Tyrannidectes* (*Pterodectes*) *fissuratus* (Hernandes and Valim 2005), *Amerodectes* (*Pterodectes*) *turdinus* (Berla 1959), and *Proctophyllodes weigoldi* Vitzthum, 1922 (Proctophyllodidae), *Mesalgoides turdinus* Černý, 1974 (Psoroptoididae),

Table 1 Prevalence and mean intensity of chewing lice infestation (Phthiraptera: Amblycera and Ischnocera) observed on *T. amaurochalinus* (n=36) and *T. rufiventris* (n=53) in three areas of Atlantic forest in southern Brazil, from July 2009 to June 2010

Host/Chewing lice	Season	Prevalence (number of hosts infected); % (n)	Mean intensity of infestation (confidence interval)	Parameter k value
Host: *T. amaurochalinus*				
Myrsidea sp.	Winter	31.3 (5)	3.2 (1.8–4.6)	0.25
Brueelia sp.		6.2 (1)	2 (0)	–
Philopterus sp.		12.5 (2)	1 (0)	–
Myrsidea sp.	Spring	60.0 (6)	8.8 (0–18.6)	0.28
Menacanthus eurysternus		20.0 (2)	7 (6–8)	–
Brueelia sp.		10.0 (1)	11 (0)	–
Philopterus sp.		20.0 (2)	2.5 (0.5–4.5)	–
Myrsidea sp.	Autumn	40.0 (4)	32 (0–88.1)	1.01[a]
Brueelia sp.		20.0 (2)	4.5 (1.1–7.9)	–
Philopterus sp.		20.0 (2)	4 (2.4–5.6)	–
Host: *T. rufiventris*				
Myrsidea sp.	Winter	84.6 (11)	51 (24.1–77.9)	0.62
Menacanthus eurysternus		7.7 (1)	8 (0)	–
B. addoloratoi		53.8 (6)	32 (5.4–58.6)	0.14
Myrsidea sp.	Spring	100.0 (15)	53.6 (30.7–76.5)	1.58
B. addoloratoi		66.7 (10)	20.4 (1.1–39.7)	0.26
Myrsidea sp.	Summer	100.0 (1)	23 (0)	–
Myrsidea sp.	Autumn	95.6 (22)	37.8 (26–49.6)	1.39
Menacanthus eurysternus		4.3 (1)	2 (0)	–
B. addoloratoi		47.8 (11)	35.4 (0–85.8)	0.13

Cells with endashes were not calculated due to small sample size

[a] Not aggregate

Analges sp. (Analgidae), *Trouessartia serrana* Berla, 1959 (Trouessartidae), and *Pteronyssoides* sp. (Avenzoariidae).

P. weigoldi and *T. serrana* were the most prevalent species on *T. amaurochalinus*, and *M. turdinus* and *T. serrana* on *T. rufiventris* (Table 2). Except during the summer, when only one specimen of *T. rufiventris* was captured, prevalence rates of the remaining species of feather mites observed in both host species did not vary significantly throughout the seasons. The genus *Analges* and *Pteronyssoides* (Table 2) were not observed on *T. rufiventris*.

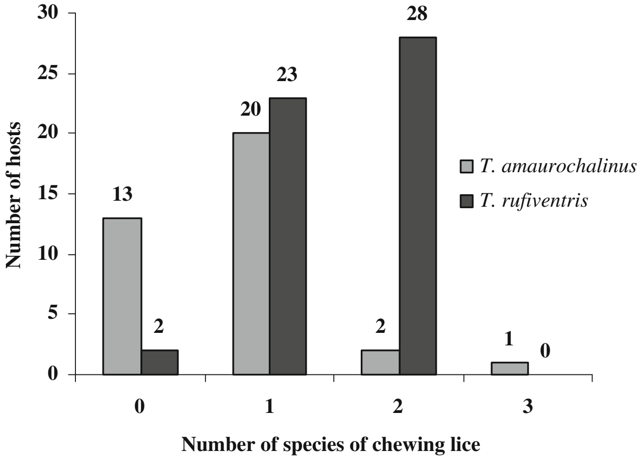

Fig. 1 Species richness of chewing lice (Phthiraptera: Amblycera, Ischnocera) observed on *T. amaurochalinus* (n=36) and *T. rufiventris* (n=53) in three areas of Atlantic forest in southern Brazil, from July 2009 to June 2010

In *T. amaurochalinus*, 33.3 % of birds were infested by one species of feather mites, 25.0 % by three and four species, 13.9 % by two, and only 2.8 % by five species. In *T. rufiventris*, 37.7 % of the specimens had three species of feather mites, 26.4 % four, 18.7 % five, 15.1 % two, and only 1.9 % one species (Fig. 2).

The average species richness of feather mites per host on *T. amaurochalinus* was lower (average=2.5; SD=± 1.28) than that of *T. rufiventris* (average=3.4; SD=± 1.03). In *T. amaurochalinus*, 52.8 % of birds had three or more species of feather mites, compared to 83.0 % for *T. rufiventris* (Fig. 2).

On *T. amaurochalinus*, only nymphs of ticks were collected; out of which, three specimens of *Amblyomma* spp., one specimen of *Amblyomma longirostre* Koch, 1844 and one specimen of *Ixodes auritulus* Neumann, 1904. On *T. rufiventris* 59 larvae and 28 nymphs of *I. auritulus*, 11

Table 2 Prevalence of feather mites (Acari: Astigmata) on *T. amaurochalinus* (*n*=36) and *T. rufiventris* (*n*=53) in three areas of Atlantic forest in southern Brazil, from July 2009 to June 2010

Host/Feather mites	Season	Prevalence (number of hosts infected); % (*n*)						
		Proctophyllodidae			*Psoroptoididae*	Analgidae	Trouessartidae	Avenzoariidae
		T. fissuratus	*A. turdinus*	*P. weigoldi*	*M. turdinus*	*Analges* sp.	*T. serrana*	*Pteronyssoides* sp.
T. amaurochalinus	Winter	12.5 (2)	18.7 (3)	75.0 (12)	18.7 (3)	43.7 (7)	50.0 (8)	12.5 (2)
	Spring	–	20.0 (2)	50.0 (5)	50.0 (5)	40.0 (4)	70.0 (7)	–
	Autumn	–	40.0 (4)	60.0 (6)	50.0 (5)	50.0 (5)	60.0 (6)	40.0 (4)
T. rufiventris	Winter	61.5 (8)	69.2 (9)	61.5 (8)	92.3 (12)	–	92.3 (12)	–
	Spring	40.0 (6)	53.3 (8)	40.0 (6)	93.3 (14)	–	100.0 (15)	–
	Summer	–	100.0 (1)	–	100.0 (1)	–	100.0 (1)	–
	Autumn	54.2 (13)	58.3 (14)	41.7 (10)	95.8 (23)	–	95.8 (23)	–

Prevalence in cells with en dashes were not observed

larvae and one nymph of *Amblyomma* spp., and one larvae of *A. longirostre* were collected. In the autumn, no ticks were observed in *T. amaurochalinus*. However, this was the season when the number of ticks in *T. rufiventris* was highest (*n*=69).

In the winter, five specimens of *Ornithoica vicina* Walker, 1949 (Diptera: Hippoboscidae) were collected on one individual of *T. amaurochalinus*. In the spring, three specimens were removed, one per host. No specimens of *O. vicina* were found on *T. rufiventris*.

In *T. amaurochalinus*, the number of species of arthropod ectoparasites composing the infracommunities ranged from two to seven (Fig. 3), resulting in an average richness of 3.5 species per host. Two infracommunities, one composed of two and the other, of four species, repeated twice each. In both communities, *P. weigoldi* and *Myrsidea* sp. were observed. On three birds captured, only one species of ectoparasite was observed. In *T. rufiventris*, the number of species of the infracommunities ranged from three to eight, resulting in an average richness of 5.4 species on each host. Of these, five infracommunities, one composed of five, three with six, and one with seven species of ectoparasites, repeated three times each. In all of them, two species of feather mite were observed (*M. turdinus* and *T. serrana*) and one species of chewing louse (*Myrsidea* sp.). Seasonality did not influence the average species richness of arthropod ectoparasites on both host species ($X^2=38.534$; *df*=3;80; $P<0.9$).

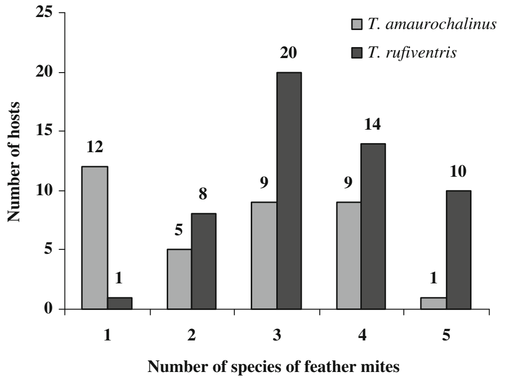

Fig. 2 Species richness of feather mites (Acari: Astigmata) observed on *T. amaurochalinus* (*n*=36) and *T. rufiventris* (*n*=53), in three areas of Atlantic forest in southern Brazil, from July 2009 to June 2010

Discussion

In the present study, the prevalence of chewing lice was 63.9 % on *T. amaurochalinus* and 96.2 % on *T. rufiventris*. Lindell et al. (2002) observed a 93 and 86 % prevalence of chewing lice on *Turdus grayi* Bonaparte, 1838 and *Turdus assimilis* Cabanis, 1850, respectively, and Enout et al. (2009), a prevalence of 96.8 % on *T. leucomelas*. In Canada, Wheller and Threlfall (1986) observed chewing lice on 61 % of the captured specimens of *Turdus migratorius* Linnaeus, 1766. Marini et al. (1996) found that 95.5 % of the sampled birds of the Turdidae family were infected.

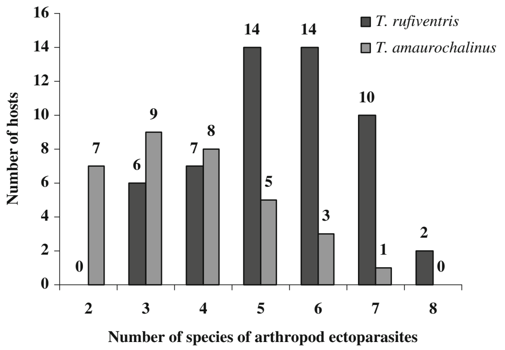

Fig. 3 Infracommunity size and the number of both *Turdus* species captured in three areas of Atlantic forest in southern Brazil, from July 2009 to June 2010

Except during the summer, we did not observe a significant increase or decrease in the average intensity of infestation of chewing lice on both host species. Although the environmental temperature did not affect the prevalence of chewing lice in the present study, this same abiotic factor, as well as the humidity, can affect the structure of the ectoparasites communities, as observed by Wiles et al. (2000), Moyer et al. (2002), and Oorebeek and Kleindorfer (2008). Furthermore, intrinsic factors, therefore more difficult to be analyzed, such as nutritional condition of the birds (Clayton 1990) and individual ability of cleaning the feathers (Clayton 1991) can affect infestation rates or the biological cycle of ectoparasites in different seasons.

Although both species of *Turdus* examined in this study are usually present in all areas of Rio Grande do Sul state, according to Belton (2004), they may become rare or absent during certain periods when wild fruits are scarce.

The average richness of species of chewing lice per host of *T. amaurochalinus* was lower than that of *T. rufiventris*. This pattern is very similar to that observed by Lindell et al. (2002) in *T. grayi* and *T. assimilis*, in which the average richness was 1.6 and 1.1, respectively. Wheller and Threlfall (1986) found an average richness of 1.2 for *T. migratorius*, while Clayton et al. (1992) 1.1 for *Turdus nigriceps* Cabanis, 1874. According to Clayton et al. (1992), these results suggest that neotropical birds do not have more species of chewing lice nor are more infested compared to birds from temperate regions. Dobzhansky (1950) suggested that the high diversity of chewing lice observed in tropical regions might be due to the high diversity of hosts.

Another factor that may explain the observed results concerns the great abundance of *T. rufiventris*, as registered by Gasperin and Pizo (2009) and Fontana (2004) in two distinct localities in the state of Rio Grande do Sul, as well due to the larger body length and body mass, when compared to *T. amaurochalinus*. According to Del Hoyo et al. (2005), the specimens of *T. amaurochalinus* possess body length between 22 and 25 cm and body mass between 52 and 73 g, while the *T. rufiventris* specimens measure between 23 and 25 cm and present body mass between 68 and 82 g. Recent studies have confirmed host density, body size, and body mass as significant predictors of parasite richness and abundance (Poulin 1997; Rózsa 1997; Morand and Poulin 1998; Tella et al. 1999; Clayton and Walther 2001).

Aggregated distributions have been observed in several parasite taxa of vertebrates (Shaw and Dobson 1995; Poulin 2007), characterized by a pattern in which many hosts have a low parasite intensity and few with a high intensity of parasites. The aggregation patterns of chewing lice species observed in this study suggest synchronization between the reproductive cycle of the parasite with the hosts, as also the best moment for dispersion. However, according to Hamstra and Badyaev (2009), the mechanisms underlying the apparent synchronization of ectoparasite and host life cycles are not well understood. Chewing lice are permanent ectoparasites, and thus might increase in abundance during host reproduction and molt because during these costly annual events, hosts might have less energy to devote to defensive physiology or preening behaviors (Møller and Rózsa 2005).

All specimens of *T. amaurochalinus* and *T. rufiventris* captured in the present study exhibited at least one species of feather mite. In addition, *T. fissuratus, M. turdinus*, and *T. serrana* are reported here for the first time on both *Turdus* species. On *T. amaurochalinus*, *P. weigoldi* was the most prevalent species, while on *T. rufiventris*, *T. serrana*. In studies conducted in Paraná state, Marini et al. (1996) also observed feather mites in 100 % of captured individuals of *T. rufiventris*. In Rio de Janeiro state, Storni et al. (2005) observed a high prevalence of *P. turdinus* on *T. albicollis*; in Distrito Federal, Kanegae et al. (2008) found *Pterodectes* sp. as the most prevalent mite infecting species of the Turdidae family. In Minas Gerais state, Enout et al. (2009) observed the prevalence of *Analges* sp. and *Trouessartia* sp. during the reproductive and molt seasons of *T. leucomelas*, respectively.

In this study, except during the summer when only one individual of *T. rufiventris* was captured, the highest prevalence rates of species of feather mite were observed in the winter and autumn infesting both species of *Turdus*. These results are similar to those obtained by Marini et al. (1996) that detected higher infestation rates of feather mites in the winter. Hamstra and Badyaev (2009) observed variations in the prevalence and abundance of two species of feather mite infesting *Carpodacus mexicanus* Müller, 1776. However, according to Jovani and Serrano (2001), this is an unexpected result, as Astigmata mites can detect molting events, moving to other microhabitats and maintaining infestation rates constant, since they do not detach from their hosts.

The two species of ticks collected, *I. auritulus* and *A. longirostre*, were also observed by Arzua and Barros-Battesti (1999), Kanegae et al. (2008), and Labruna et al. (2007) infesting *Turdus* species. Only larvae and nymphs of ticks were collected. According to Venzal et al. (2005), wild birds are hosts of many immature ticks.

In the autumn, no ticks were collected on *T. amaurochalinus,* but tick abundance was highest for *T. rufiventris*. Arzua and Barros-Battesti (1999) also observed the highest number of larvae and nymphs of *I. auritulus* on birds during the autumn, but this difference was not correlated with any weather variable. According to Oorebeek and Kleindorfer (2008), more ticks are observed when humidity is higher and temperatures, moderate. The higher occurrence of ticks on *T. rufiventris* might be due to its behavior of foraging on the ground (Belton 2004), which is the habitat of many immature ticks until attaching to their hosts (Szabó et al. 2009).

Only specimens of *O. vicina* were observed on *T. amaurochalinus*. Analyzing collections of hippoboscid flies of the Paraná state, Graciolli and Carvalho (2003) observed an association between *O. vicina* and *T. rufiventris*.

In the present study, the communities of arthropod ectoparasites on both species of *Turdus* were similar. However the richness was higher on *T. amaurochalinus*. According with Lindell et al. (2002), the higher richness is not always associated to the size of the area and/or the heterogeneity of the habitat, but rather with ecological or even physiological factors of each host species. Furthermore, our results suggest synchronization between the reproductive period of some species of chewing lice with the species of *Turdus*, because the lowest levels of aggregation were observed in the spring.

Acknowledgments The authors thank Dr. Michel Paiva Valim for the help in the identification of species of chewing lice and feather mites as well as comments on this manuscript, Ph.D student of the Graduate Program in Parasitology (UFPel), Carolina Silveira Mascarenhas, for helping in the identification of chewing lice and gender determination, and Ph.D. Jason Weckstein (FMNH), Dr. Demétrio Luis Guadagnin (UFSM), and Dr. Ana Beatriz Barros de Moraes (UFSM) for their comments and suggestions to this study. Financial support was provided by a Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) granted to H. L. da C. Amaral.

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