Parasitism of *Ixodes* (*Multidentatus*) *auritulus* Neumann (Acari: Ixodidae) on Birds from the City of Curitiba, State of Paraná, Southern Brazil

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The tick-bird relationship of 56 specimens of birds (Passeriformes and Columbiformes) collected in the city of Curitiba, State of Paraná, between 1990 and 1995, among which 102 specimens of Ixodes (Multidentatus) auritulus *were found and analyzed. New host records were also produced including the first report of* I. auritulus *on a Columbiformes bird in Brazil.*

Key words: *Ixodes auritulus* - tick-bird relationship - new host birds - Paraná - Brazil

The description of *Ixodes auritulus* Neumann, 1904, was based on four females collected by Labrun on an undetermined bird from Punta Arenas, Chile. Three of the four type specimens are deposited in the Paris Museum of Natural History (access nos. 2474 and 2483) and one in the École Nationale de Vétérinaire, Toulouse (Arthur 1960). Dumbleton (1953), in his study of ticks of the New Zealand sub-region, described a male collected together with a female and a nymph, in a petrel's (*Pelecanoides urinatrix*) nest material, as *I. auritulus*. Nevertheless Arthur (1960), highlighted characters which distinguished the New Zealand populations from those *I. auritulus* sens. str., and Dumbleton (1961) considered the New Zealand forms collected on seabirds as subspecies designating *I. auritulus zealandicus* subsp. nov., and he considered the American forms collected on land birds as *I. auritulus auritulus*. Kohls and Clifford (1966) described the male of *I. auritulus auritulus* from Rio El Ganso, Magallanes, Chile, February 26, 1961, which is near Punta Arenas, the type area of *I. auritulus*. This specimen was deposited in the Rocky Mountain Laboratory (RML 37869). Clifford et al. (1973) included this species in the *Multidentatus* subgenus.

In Brazil, specimens of *I.* (*Multidentatus*) *auritulus*, were collected on *Knipolegus nigerrimus* (Tyrannidae: Passeriformes), *Thamnophilus ruficapillus and T. caerulescens* (Formicariidae: Passeriformes) birds from Serra de Itatiaia, Atlantic Forest, State of Rio de Janeiro in 1922 (Cooley & Kohls 1945). However, these specimens were deposited in Bureau of Animal Industry, U.S. Department Agriculture, accession no. (BAI-25088, one female, on *K. nigerrimus* collected by EG Holt in Feb. 2, 1922); U.S. National Museum, accession no. (Nat'l Mus-287, one female, on *Tamnophilus ruficapillus*) and (Nat'l Mus-322, five females, on *T. caerulescens*) collected by EA Chapin, in Feb. 2, and Feb. 10, 1922, respectively.

Specimens of *I. auritulus* were collected on Turdidae for the first time in the State of Paraná, during bird banding in the Passaúna Park of the city of Curitiba, during 1990 to 1992 (Arzua et al. 1994). These results led Marini et al. (1996) to investigate the prevalence of ticks on birds from mountain and lowland forest areas of the State of Paraná. However, during their investigation (from 1991 to 1995), they observed predominant infestation by *Amblyomma* larvae (94%) as oppossed to immature stages of *Ixodes* (not *auritulus*) (6%).

The purpose of this work was to investigate the mainly green areas (parks) of the city of Curitiba in order to increase the information available on the relationship between *I. auritulus* and birds and providing new host records.

MATERIALS AND METHODS

The city of Curitiba (25º25'40''S, 49º16' 23''W), with 430 km^2, is located in the Curitiba uplands sub-region (Maack 1968), 934.57 m above sea level (IBGE 1995). Subtropical forests with *Araucaria angustifolia*, which predominated in this region in the past, are now reduced to small patches with altered primary forest or secondary vegetation and some preserved areas in the city and its

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surroundings. According to Koppen's classification, the climate type is Cfb (mesothermic-humid with well distributed rainfall and mild summers), with an annual rainfall ranging from 1,250 to 2,000 mm^3, and an annual mean temperature ranging from 14ºC to 19ºC (Coelho 1990).

For this study, five parks in the city of Curitiba, and one adjacent area to the city of Almirante Tamandaré (Primavera Park with 800,000 m^2) were investigated. Investigations in the Passaúna Park (6,500.000 m^2) began in 1990 during bird banding. As of January 1992, investigations began in the Barigui (1,400.000 m^2), Iguaçu (8,264.316 m^2) and Reinhardt Maack (78,000 m^2) parks. The Barreirinha (275,380 m^2) and Primavera parks, were investigated only during 1995. All the collections ended in December 1995. These parks are open to public visitation, suffering a great deal of anthropic activity over weekends.

From 1992 to 1995, the birds were captured every six weeks in all the areas, using 20 "mist-net" nets of 12 m x 3 m, distributed 20 cm above the ground. During every capture, the nets were opened around sunrise and operated until late afternoon.

Each captured bird was banded and visually examined for ticks using a magnifying hand glass. Ticks were found around the hosts' head, eyes and neck. The ticks were collected with tweezers and preserved in 70º ethanol for taxonomic identification. After banding, the birds were set free.

The taxonomical identification of the hosts is based on the scheme at Meyer De Schauensee (1983). For bird families, the nomenclature proposed by Scherer Neto and Straube (1995) was used. Adult ticks were identified according to Nuttall and Warburton (1911), and Mendez-Arocha and Ortiz (1958). Nymphs were identified according to Cooley and Kohls (1945) and Durden and Keirans (1996). For larvae we used the description of Clifford et al. (1973). All specimens of ticks were deposited in the Museu de História Natural Capão da Imbuia (MHNCI), Curitiba.

The tick infestation indices were calculated by the arithmetic mean (mean number of ticks among the individuals of a taxon, excluding non infested individuals) to establish the infestation rate for each taxon.

From 1992 to 1995, the monthly rainfall indices and monthly average temperature were supplied by the Sistema Meteorológico do Paraná (Simepar).

Spearman rank correlations (r_s) between larvae, nymph and adult numbers of *I. auritulus* and meteorological data (rainfall and temperature), as well as time (in order to investigate the presence of seasonal infestation) were conducted. The statistical analysis was performed using the SPSS statistical package.

RESULTS

A total of 922 birds was examined from 1990 to 1995. Fifty six specimens (6.1%) were infested with *I. auritulus* and four specimens presented double infestation with *Amblyomma* sp. The access numbers of *I. auritulus* lots as well as their host, green area and collection date, are shown on Table I.

We also found 32 birds (3.5% of the total) infested by 88 immature *Amblyomma* sp. ticks. The most infested park was the Passaúna (70 specimens collected in 15 birds). The number of *Amblyomma* sp. specimens and infested birds in the Barigui and Iguaçu parks were equivalent (6/6), in the Reinhardt Maack (3/2), in the Barreirinha (1/1) and in the Primavera (2/2). Due to the difficulty in identifying the immature stages of *Amblyomma*, only the data concerning the *I. auritulus* species was considered in this study. Moreover, birds host all the phases of their biological cycle.

The number of birds, examined and found to be infested by *I. auritulus* from the green areas are demonstrated in Table II. The Passaúna Park presented the largest number of *T. rufiventris*, examined with 22.5% (16/71) infested hosts. On the other hand, the Barigui Park presented 25% of *T. rufiventris* infested (10/40), and the same was observed for the Reinhardt Maack Park (11/53, 20.8%). The Iguaçu Park presented the smallest number of *T. rufiventris* examined, although 6.3% (1/16) of the hosts were infested. The Barreirinha and Primavera parks presented 6% (3/50) and 6.8% (4/59), infestion respectively.

The number and percentage of *I. auritulus* larvae, nymphs and females and the total tick/bird infestation indices are shown in Table III. *T. rufiventris* was more infested (87.3%) by immature and adult forms of *I. auritulus* than any other host. The tick-host infestation index for *T. rufiventris* (2:1) was also observed for *T. amaurochalinus* and *Conopophaga lineata*.

The monthly rainfall indices and monthly average temperature from 1992 to 1995 are shown in Fig. 1.

Spearman rank correlations between the numbers of larvae, nymphs and females of *I. auritulus*, collected monthly from 1992 to 1995 (Fig. 2), and monthly meteorological data were calculated. The number of females increased significantly between September through November ($r = 0{,}645$; $p = 0{,}007$), and was not correlated with rainfall or temperature. Between larvae and nymphs, the correlation was significantly positive ($r = 0{,}764$; $p = 0{,}001$). Nevertheless, there was no monthly or sea-

TABLE I

Material of *Ixodes auritulus* deposited in Museu de História Natural Capão da Imbuia, collected on birds from the city of Curitiba, State of Paraná, Brazil, from 1990 to 1995

Lot number	Number of ticks	Hosts	Parks	Date
MHNCI 91	1F	*Turdus albicollis*	Passaúna	05/12/90
MHNCI 92	1F	*T. rufiventris*	Passaúna	05/12/90
MHNCI 102	1N, 1L	*Conopophaga lineata*	Passaúna	14/05/92
MHNCI 93	1N, 3L	*T. rufiventris*	Passaúna	14/05/92
MHNCI 94	2N, 6L	*T. rufiventris*	Passaúna	14/05/92
MHNCI 103	1N	*Syndactyla rufosuperciliata*	Passaúna	14/05/92
MHNCI 100	2N, 2L	*T. rufiventris*	Passaúna	21/06/92
MHNCI 101	4F	*T. rufiventris*	Passaúna	30/11/92
MHNCI 518	2N	*T. amaurochalinus*	Passaúna	23/03/93
MHNCI 543	1N	*Syndactyla rufosuperciliata*	Barigui	25/03/93
MHNCI 572a	1F, 1N	*T. rufiventris*	Iguaçu	23/09/93
MHNCI 573	1N	*Syndactyla rufosuperciliata*	Barigui	27/09/93
MHNCI 574	1N	*T. rufiventris*	Barigui	27/09/93
MHNCI 575	1F, 1N	*T. rufiventris*	Barigui	27/09/93
MHNCI 557	1N	*Syndactyla rufosuperciliata*	Passaúna	20/10/93
MHNCI 558	1F	*T. rufiventris*	Passaúna	20/10/93
MHNCI 576	1L	*T. rufiventris*	Barigui	22/10/93
MHNCI 577	1F, 1N	*T. rufiventris*	Passaúna	10/11/93
MHNCI 578	1F	*T. rufiventris*	Passaúna	10/11/93
MHNCI 579	1N	*T. rufiventris*	Passaúna	10/11/93
MHNCI 580	1F	*Columbina talpacoti*	Reinhardt Maack	16/11/93
MHNCI 581	1F, 1N	*T. rufiventris*	Reinhardt Maack	16/11/93
MHNCI 582	1F	*T. rufiventris*	Reinhardt Maack	16/11/93
MHNCI 583	2F	*T. rufiventris*	Reinhardt Maack	16/11/93
MHNCI 584	1F	*T. rufiventris*	Reinhardt Maack	16/11/93
MHNCI 570	1N	*T. rufiventris*	Passaúna	06/07/94
MHNCI 585	1F	*T. rufiventris*	Passaúna	14/10/94
MHNCI 586	2F, 1N	*T. rufiventris*	Passaúna	14/10/94
MHNCI 587	1N	*T. rufiventris*	Passaúna	14/10/94
MHNCI 588b	2N	*T. rufiventris*	Barigui	19/10/94
MHNCI 589	2F	*T. rufiventris*	Barigui	19/10/94
MHNCI 590	1F	*T. rufiventris*	Barigui	19/10/94
MHNCI 591	2F	*T. rufiventris*	Barigui	19/10/94
MHNCI 592	1L	*Basileuterus leucoblepharus*	Barigui	19/10/94
MHNCI 593	1F	*T. rufiventris*	Reinhardt Maack	20/10/94
MHNCI 594	1F	*T. rufiventris*	Reinhardt Maack	20/10/94
MHNCI 595	1F	*T. rufiventris*	Reinhardt Maack	20/10/94
MHNCI 596	1F	*T. rufiventris*	Barigui	18/11/94
MHNCI 597	1F	*T. rufiventris*	Barigui	18/11/94
MHNCI 598	1F	*T. rufiventris*	Barigui	18/11/94
MHNCI 599	1F	*T. rufiventris*	Reinhardt Maack	22/11/94
MHNCI 600	1F	*T. rufiventris*	Reinhardt Maack	22/11/94
MHNCI 601	4F	*T. rufiventris*	Reinhardt Maack	22/11/94
MHNCI 602	1F, 1N	*T. rufiventris*	Reinhardt Maack	22/11/94
MHNCI 603	1N	*T. rufiventris*	Passaúna	20/02/95
MHNCI 604	1N	*Trichotraupis melanops*	Barreirinha	21/02/95
MHNCI 605	2N	*T. rufiventris*	Barreirinha	05/04/95
MHNCI 606	1N	*T. rufiventris*	Primavera	08/04/95
MHNCI 649	2N, 4L	*T. rufiventris*	Primavera	08/04/95
MHNCI 650	1N	*T. rufiventris*	Primavera	08/04/95
MHNCI 651	1N	*T. rufiventris*	Primavera	08/04/95
MHNCI 607c	1N	*T. rufiventris*	Passaúna	28/06/95
MHNCI 608d	8L	*T. rufiventris*	Barreirinha	29/06/95
MHNCI 609	1N	*Clibanornis dendrocolaptoides*	Passaúna	10/08/95
MHNCI 610	1F	*T. rufiventris*	Barreirinha	04/10/95
MHNCI 611	1F, 1N	*T. rufiventris*	Passaúna	07/10/95

Date: is represented by day, month, year; F: female; N: nymph; L: larva; double infestation with *Amblyomma* sp. is represented by a: 1L; b: 1N; c: 6L; d: 1L.

TABLE II

Number of examined and infested birds by *Ixodes auritulus* in the Curitiba green areas, State of Paraná, Brazil, from 1990 to 1995

Parks	Examined birds																				Total	
	Turdus rufiventris		*Turdus amaurochalinus*		*Turdus albicolis*		*Conopophaga lineata*		*Syndactyla rufosuperciliata*		*Columbina talpacoti*		*Clibanornis dendrocolaptoides*		*Basileuterus leucoblepharus*		*Trichotraupis melanops*		Others birds			
	H	(I) T	H	(I) T	H	(I) T	H	(I) T	H	(I) T	H	(I) T	H	(I) T	H	(I) T	H	(I) T	H	(I) T	H	(I) T
Passaúna	71	(16) 36	5	(1) 2	6	(1) 1	6	(1) 2	2	(2) 2	1	(0) 0	9	(0) 0	3	(0) 0	3	(1) 1	159	(0) 0	265	(22) 44
Barigui	40	(10) 14	4	(0) 0	-		7	(0) 0	5	(2) 2	3	(0) 0	9	(1) 1	-		6	(0) 0	91	(0) 0	165	(13) 17
Iguaçu	16	(1) 2	-		3	(0) 0	3	(0) 0	7	(0) 0	-		11	(0) 0	2	(0) 0	2	(0) 0	48	(0) 0	92	(1) 2
R. Maack	53	(11) 17	5	(0) 0	1	(0) 0	5	(0) 0	-		2	(1) 1	-		2	(0) 0	1	(0) 0	51	(0) 0	120	(12) 18
Barreirinha	50	(3) 11	3	(0) 0	-		2	(0) 0	2	(0) 0	1	(0) 0	7	(0) 0	3	(1) 1	-		75	(0) 0	143	(4) 12
Primavera	59	(4) 9	5	(0) 0	3	(0) 0	3	(0) 0	-		2	(0) 0	6	(0) 0	-		-		59	(0) 0	137	(4) 9
Total	289	(45) 79	22	(1) 2	13	(1) 1	26	(1) 2	16	(4) 4	9	(1) 1	42	(1) 1	10	(1) 1	12	(1) 1	483	(0) 0	922	(56)102

H: hosts examined; I: hosts infested; T: ticks collected.

sonal significant correlation nor with any metereological data, although an increase in the larval and nymph numbers during the Autumm (and in nymphs during the Spring) was observed. The correlation between the mean temperatures and the rainfall was significantly negative ($r = 0,706$; $p = 0,002$), reflecting the decreased rainfall during the colder months.

DISCUSSION

There are two other Brazilian collections with *I. auritulus* material: the Instituto Butantan mite collection, with five immature specimens collected from *Penelope superciliaris* and *Penelope* sp. (Cracidae: Galliformes) birds, from the State of São Paulo, 1956 (Barros-Battesti & Knysak 1999), and the Laboratório de Doenças Parasitárias of the Faculdade de Medicina Veterinária e Zootecnia, Universidade de São Paulo mite collection, with one female (collection no. 77) collected in September, 1997 from *T. ruficapillus* (Formicariidae: Passeriformes) from Herval, State of Rio Grande do Sul (Marcelo Bahia Labruna, pers. commun.). The specimens of *I. auritulus* collected in this study and their hosts shown on Table I, constitute the main Brazilian *I. auritulus* collection.

Considering the extension of the green areas and the study period (Table II), the Barreirinha (275,380 m^2) and Primavera (800,000 m^2) parks, studied only during 1995, presented a large number of investigated birds but only small infestation indices (2.8% and 2.9% respectively). The Passaúna (6,500.000 m^2) and Barigui (1,400.000 m^2) parks were best represented in the number of samples of infested birds, with infestation indices of 8.3% and 7.8%, respectively. The largest area, the Iguaçu Park (8,264.316 m^2) presented the smallest number of infested birds with only one infested specimen (1%). On the other hand, the park with the smallest area, Reinhardt Maack Park (78,000 m^2), had the highest infestation index (10%). Thus, the Reinhardt Maack, Passaúna and Barigui parks offer the best conditions for the continuation of bioecological studies of *I. auritulus*, due to the higher levels of infestation.

Marini et al. (1996) observed that several endemic birds of the Atlantic Forest from Paraná, showed high ectoparasite prevalence for some groups (e.g. 88.7% for feather mites during the Winter) or for specific host taxa (e.g. 85.3% for ticks on Dendrocolaptidae). In their study, these authors investigated the dense montain cloud forest area, located at ≈ 1,000 m above sea level, and collected 120 specimens of *Amblyomma* sp. larvae and a single *Ixodes* sp. nymph during the Winter. Nevertheless, they collected seven *Ixodes* sp. nymphs and a single *Amblyomma* sp. larvae dur-

TABLE III

Number and % of larvae, nymphs and females of *Ixodes auritulus* collected on bird species, and total tick/host infestation indices, from 1990 to 1995 in Curitiba, State of Paraná, Brazil

	Ticks									
		Larvae		Nymphs		Females		Total		Total tick/host
Hosts	No.	No.	%	No.	%	No.	%	No.	%	infestation indices
Passeriformes	**55**	**26**	**25.7**	**36**	**35.6**	**39**	**38.6**	**101**	**99**	**1.8**
Turdidae	47	24	26.1	29	31.5	39	42.4	92	90.2	2
Turdus rufiventris	45	24	27	27	30.3	38	42.7	89	87.3	2
Turdus albicolis	1	-	-	-	-	1	100	1	1	1
Turdus amaurochalinus	1	-	-	2	100	-	-	2	2	2
Formicariidae	1	1	50	1	50	-	-	2	2	2
Conopophaga lineata	1	1	50	1	50	-	-	2	2	2
Furnariidae	5	-	-	5	83.3	-		5	5	1
Syndactyla rufosuperciliata	4	-	-	4	100	-	-	4	3.9	1
Clibanornis dendrocolaptoides	1	-	-	1	100	-		1	1	1
Emberizidae	1	-	-	1	100	-	-	1	1	1
Trichothraupis melanops	1	-	-	1	100	-	-	1	1	1
Parulidae	1	1	100	-	-	-	-	1	1	1
Basileuterus leucoblepharus	1	1	100	-	-	-	-	1	1	1
Columbiformes	**1**	**-**	**-**	**-**	**-**	**1**	**100**	**1**	**1**	**1**
Columbidae	1	-	-	-	-	1	100	1	1	1
Columbina talpacoti	1	-	-	-	-	1	100	1	1	1
Total	56	26	25.5	36	35.3	40	39.2	102	100	1.8

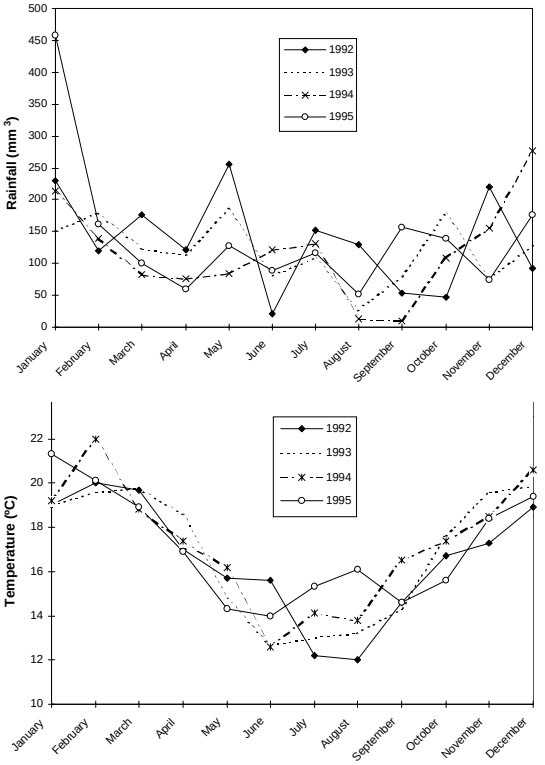

Fig. 1: monthly rainfall and average temperature from 1992 to 1995 in the city of Curitiba, State of Paraná, Brazil.

ing the Summer, in the same area. We examined all the ticks collected during their study and identified none of the specimens of *Ixodes* as *I. auritulus*. Therefore, the Curitiba green areas appear to represent good distribution areas for this species.

The ectoparasites of Neotropical birds are poorly studied, even though in other regions, studies have demonstrated that ectoparasitism may decrease birds' reproductive success by increasing mortality rates or decreasing development rates of nestlings, and the ability to attract mates (Duffy 1983, Clayton 1990, Chapman & George 1991). Nevertheless, the veterinary and medical importance of *I. auritulus* is not known (Durden & Keirans 1996).

Regarding the correlation between monthly rainfall and average temperatures, from 1992 to 1995, with larvae, nymphs and female ticks monthly distribution (Figs 1, 2), a positive significant correlation for females ($r = 0{,}645$; $p = 0{,}007$) during the Spring months (from September to November) was observed. The numbers of larvae and nymphs showed peaks (especially nymphs) from March to June, and September to November). Since larvae and nymphs present corresponding peaks, there is a significant positive correlation between them. However, these numbers were not signifi-

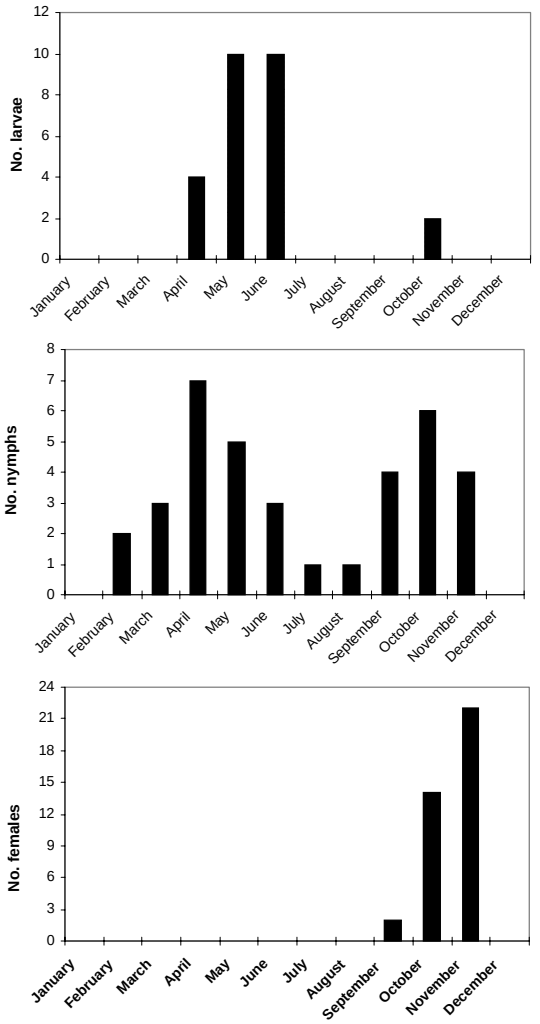

Fig. 2: monthly distribution of larvae, nymphs and females of *Ixodes auritulus* on birds collected from 1992 to 1995, in the city of Curitiba, State of Paraná, Brazil.

cant when correlated to the months of the year. In Paraná, in forest areas with *Araucaria angustifolia*, where the temperatures decrease between Autumn and Spring, *I. auritulus*, seems to have a longer biological cycle than other Brazilian *Ixodes* species, because larvae were most abundant during the Autumn of 1992 and in the Autumn and beginning of Winter of 1995. However, only two larvae were collected between 1993 and 1994, one specimen in each Spring (Table I, Fig. 2). Unfortunately, there are no other studies on the life cycle of other Brazilian *Ixodes* species and these results could be different for other areas.

In Southern Brazil, the *I. auritulus* hosts are mainly Passeriformes birds, and in the green areas of the city of Curitiba, this species infests mainly *T. rufiventris* (Table III). However, this tick also occurs in other geographic regions, on other bird orders, such as: Sphenisciformes, Falconiformes, Galliformes, Craciformes, Charadriiformes and Apodiformes (Cooley & Kohls 1945, Arthur 1960).

Regarding host distribution, except for *C. dendrocolaptoides*, that has a limited distribution occurring from Argentina to Southern Brazil, including Rio Grande do Sul and Paraná, all those Passeriformes and Columbiformes birds are well distributed in South America. However, there are no records of migration between the countries (Meyer de Schauensee 1983). In Brazil, *T. amaurochalinus* does migrate, probably from South to North, up to the State of Amazonas (Sick 1984). By means of bird banding, carried out during this study, migration between parks was recorded only for *T. rufiventris.*

This study increases the gamut of host birds of *I. auritulus* for Brazil. The new records include the following bird families: Furnariidae, Parulidae and Emberizidae (Passeriformes) and Columbidae (Columbiformes). For Formicaridae and Turdidae, the following species are added: *C. lineata* e *T. amaurochalinus*, respectively, as hosts. This is the first report of *I. auritulus* on *Columbina talpacoti*.

One male of *I. auritulus* was recorded from Chile, from an unknown host and source (Kohls & Clifford 1966). Since parthenogenesis has not been recorded for *Ixodes* (Woolley 1987, Oliver Jr 1989), the absence of males on the examined hosts (N = 922) during this study, leads us to believe that its absence on hosts must be related to a possible dependence with a nest microhabitat, as a strategy for mating and not necessarily a direct interdependence with the host. However, these questions can only be answered by the continuation of this study in field and laboratory conditions.

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