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New host and locality records for the *Ixodes auritulus* (Acari: Ixodidae) species group, with a review of host relationships and distribution in the Neotropical Zoogeographic Region

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Abstract. New Neotropical records are presented for ticks belonging to the *Ixodes auritulus* Neumann, 1904, species group, together with a review of hosts and localities from which members of this complex have previously been collected. The range of the *I. auritulus* species group is now understood to include Colombia, and 15 bird species are listed as new hosts. From Guatemala to southern Argentina and Chile, specimens of the *I. auritulus* group have been found on birds belonging to the orders Ciconiiformes, Columbiformes, Falconiformes, Galliformes, Passeriformes, Piciformes, Procellariiformes and Tinamiformes. Passeriform birds are probably the principal hosts, sustaining tick populations throughout the Neotropics. Collection data have yielded four areas – southern South America (from 56° S to 51° S), southern Brazil (25° S–22° S), south-central Peru (14° S–10° S) and Central America (10° N–15° N) – where the *I. auritulus* group appears to commonly parasitize birds, but additional collections may show that the range of this complex is less discontinuous than currently perceived. Several morphological differences are described for ticks within and among these areas, but it is still unclear whether the *I. auritulus* group comprises more than one species.

Introduction

Ixodes auritulus Neumann, 1904, is a bird tick found in the Australian, Ethiopian, Nearctic and Neotropical Zoogeographic Regions (Guglielmone et al. 2003). This tick is a member of the subgenus *Multidentatus* Clifford, Sonenshine, Keirans and Kohls, 1973, as defined by Clifford et al. (1973), which also includes *I. amersoni* Kohls, 1966, *I. diomedeae* Arthur, 1958, *I. eichorni* Nuttall, 1916, *I. eudyptidis* Maskell, 1885, *I. kerguelensis* André and Colas Belcour,

1942, *I. kohlsi* Arthur, 1955, *I. laysanensis* Wilson, 1964, *I. murreleti* Cooley and Kohls, 1945, *I. paranaensis* Barros-Battesti, Arzua, Pichorim and Keirans, 2003, *I. percavatus* Neumann, 1906, *I. rothschildi* Nuttall and Warburton, 1911 and *I. zumpti* Arthur, 1960. The only other Neotropical *Multidentatus* is *I. paranaensis*. Only one species of this subgenus (*I. murreleti*) occurs in the Nearctic.

Unlike *I. paranaensis*, known only from southern Brazil, where it parasitizes the apodid *Streptoprocne biscutata* (Barros-Battesti et al. 2003), and *I. murreleti*, known from a single female taken from a Scripps' Murrelet, *Synthliboramphus hypoleucus* (Charadriiformes), in northern Mexico, *I. auritulus* has been collected on a variety of hosts in Guatemala, Costa Rica, Venezuela, Ecuador, Peru, Brazil, Uruguay, Chile and Argentina (Guglielmone et al. 2003). As noted by Nuttall (1916) and Arthur (1960), there is considerable morphological variation among specimens of *I. auritulus*. Therefore, we prefer to use the term *I. auritulus* species group until a more precise definition of this taxon is proffered (see Materials and methods).

Herein we present new host and distributional records that expand our knowledge of the *I. auritulus* group, together with a review of Neotropical literature on this complex. Such a summary should prove useful to others interested in tick zoogeography and host relationships.

Materials and methods

We have adopted the comparative diagnoses of Nuttall (1916), Cooley and Kohls (1945), Keirans and Clifford (1978), Durden and Keirans (1996) and Barros-Battesti et al. (2003) for separating the three species of *Multidentatus* found in the Nearctic and Neotropical Regions:

Females	
1) With an anteriorly directed spur on palpal segment I (trochanter)	2
Without an anteriorly directed spur on palpal segment I	*I. murreleti* (Nearctic)
2) With two spurs on coxae II and III	*I. auritulus* species group (Neotropical/other Regions)
With one spur on coxae II and III	*I. paranaensis* <2*> (Neotropical)
Nymphs (the nymph of *I. murreleti* is unknown)	
1) With cornua	*I. auritulus* species group
2) Without cornua	*I. paranaensis*
Larvae (the larva of *I. murreleti* is unknown)	
1) Trochanters of legs I and II with spurs	*I. auritulus* species group
2) Trochanters of legs I and I without spurs	*I. paranaensis*

For this analysis, we compiled all records of *I. auritulus* in the United States National Tick Collection (USNTC), Georgia Southern University, Statesboro, that had not previously been included in scientific papers, as well as recent

collections from Chile. The Chilean specimens have been deposited in the collection of the Departamento de Ciencias Pecuarias (CDCP), Laboratorio de Zoología, Unversidad de Concepción, Chillán, Chile. Questionable records of *I. auritulus* from mammals, unidentified birds, or specimens lacking host data were excluded from this study. However, the following literature records were accepted: Nuttall (1916), Ault (1943), Cooley and Kohls (1945), Cassamagnaghi and Bianchi Bazerque (1951), Arthur (1960), Tonn et al. (1963), Kohls and Clifford (1966), Arnold (1970), Jones et al. (1972), Arzua and Barros-Battesti (1999), Barros-Battesti and Knysak (1999), Robbins et al. (2001), Arzua et al. (2003), and González-Acuña et al. (2004).

USNTC records of *I. auritulus* not mentioned in the above references are: 2♀♀ from *Nothoprocta pentlandii*, Peru, Cuzco, Ocongate, Tinki, 3500–4000 m altitude, July 20, 1949, coll. C. Kalinowski (RML 31449); 1 F 1 nymph (N) from *Troglodytes m.* (*monticola*?) *hormensis*, Chile, Punta Arenas, Jan. 16, 1940, coll. C.C. Sanborn (RML 35884); 3 FF, 4 NN, 3 larvae (LL) from *Turdus falcklandii*, Chile, Navarino Island, Puerto Williams, Feb. 2, 1964, coll. G.E. Watson (RML 117503); 1 F, same data as above except Jan. 19, 1964 (RML 117505); 1 N 2 LL from *Aphrastura spinicauda*, same data as above except Feb. 2, 1964 (RML 111506);1 NN 6 LL from *Aphrastura spinicauda*, Chile, Fuerte Bulnes, Apr. 17, 1971 (RML 118074); 1 N, (RML 118075); 2 NN from *Aphrastura spinicauda* (RML 118078); 1 N (RML 118079); 7 LL (RML 118080); 2 NN 1 L (RML 118081); 1 N (RML 118082); 1 L (RML 118084); 1 N 9 LL (RML 118085); 2 NN 3 LL (RML 118086); 4 NN 7 LL (RML 118087); 1 N (RML 118090); 19 LL (RML 118092); 2 NN 6 LL (RML 118093); 1 N, same host, Chile, Punta Arenas, Apr. 15, 1971 (RML 118091); 1 L from *Catharus gracilirostris*, Costa Rica, Guanacaste Province, 4.42 km NE Tilarán, Dec. 29, 1964 (RML 47604); 1 F 3 L from *Phalcoboenus (= Poliburos) australis*, Argentina, Isla de los Estados, Bahía Crossley, Apr. 26, 1971 (118072); 2 NN 34 LL, same data as above (RML 118089); 3 NN 4 LL, same host, Argentina, Isla de los Estados, Isla Observatorio, May 17, 1971 (RML 118073); 9 NN 3LL, same data as above (RML 118076); 1 F 1 N from *Pelecanoides magellani*, Argentina, Isla de los Estados, Puerto Cook, May 15, 1971 (RML 118077); 1 F from *Thraupis cyanocephala*, Colombia, Zipacon, Nov 7, 1975, coll. Wheelwright (RML 66854); 1 F from *Nephelornis oneilli*, Peru, Huanuco, Unchog, pass between Churubamba and Hda. Paty, NNW Acoma, 3450 m altitude, July 19, 1984, coll. L.J. Brakley (RML 117610); 5 NN 6 LL from *Atlapetes pallidinucha*, Colombia, Inderena, Parque Nacional de Purace, Feb. 5, 1989, coll. Y.O. Willis (RML 120538); 2 NN 13 LL, same data as above (RML 120529); 2 LL from *Diglossa albilatera*, same data as above (RML 120528); 3 LL from *Atlapetes schistaceous*, same data as above except Feb. 6, 1989 (RML 120523); 1 L from *Tangara vassorii*, same data as above (RML 120522); 2 LL from *Anisognathus lacrymosus*, same data as above (RML 120525).

The following new Chilean records of the *Ixodes auritulus* species group from Puerto Williams, deposited in CDCP, were also included in this study: 3

NN 2 LL from *Zonotrichia capensis*, Feb. 2, 2004; 5 NN 1 L from *A. spinicauda*, Feb. 2, 2004; 2 NN, same host, Feb. 10, 2004; 1 L from *Elaenia albiceps*, Feb. 8, 2004; 1 L from *Pygarrichas albogularis*, Feb. 17, 2002. All specimens were collected by S. Ippi.

Bird hosts were tabulated by order and family to roughly estimate tick host preferences. In compiling our host list, we followed the classificatory scheme of Meyer de Schauensee (1982), complemented by Dickinson (2003). Birds in the genera *Poecilothraupis* and *Planesticus* were reassigned to the genera *Anisognathus* and *Turdus*, respectively. The record of Nuttall (1916) from *Trupialis militaris* in southern Argentina is thought to correspond to *Sturnella loyca*. *Nycticorax scapularis*, described as a probable host of *I. auritulus* by Ault (1943), is here considered to be *Nycticorax nycticorax*. *Junco vulcani* of Tonn et al. (1963) is here treated as *Zonotrichia vulcani*.

Results

Males of *I. auritulus* are not commonly found on hosts (Kohls and Clifford 1966) and none were studied during this survey. Morphological variation among specimens identified as *I. auritulus* is common. Ault (1943) depicted an *I. auritulus* female (currently unavailable) that could be considered outside the definition of subgenus *Multidentatus* because its dental formula was 4/4 and coxa IV was both unusually shaped and armed with two spurs; however, these characters were ascribed to intraspecific variation. The same specimen possessed the typical anteriorly projecting spur on palpal segment I and spurred trochanters on all legs. We therefore believe that the specimen reported by Ault belongs to the *I. auritulus* species group. Cassamagnaghi and Bianchi Bazerque (1951) published figures of a nymph of *I. auritulus* from Uruguay, with large, broad auriculae but characters that are otherwise compatible with this group. In females of *I. auritulus*, the shape of the auriculae, the dentition (Peruvian specimens), and the shape of the spur on palpal segment I (Guatemalan specimens) were found by Arthur (1960) to differ from those of the type. The female specimen of *I. auritulus* reported from a Costa Rican *Thryorchilus browni* by Tonn et al. (1963) is unusually small, with a scutum that is much longer than broad as compared with typical specimens. One of us (JMV) compared *I. auritulus* specimens from Brazil and Chile and found subtle differences between them in the size of the auriculae and the degree of development of the spur on palpal segment I.

Known avian hosts of the *I. auritulus* group, together with their countries of origin, tick stages found, and references or depositories for tick specimens, are summarized in Table 1, where numbers in parentheses alongside country names refer to the specific localities listed in Table 2. The six records of *I. auritulus* reported here for Colombia are the first for that country. As well, the following birds are new hosts of this tick: *Anisognathus lacrymosus*, *Aphrastura spinicauda*, *Atlapetes pallidinucha*, *A. schistaceus*, *Diglossa albilatera*, *Elaenia*

Table 1. Avian hosts, countries of origin, tick stages, and references or depositories for *Ixodes auritulus* specimens from the Neotropical Zoogeographic Region.

Host	Country	F	N	L	Source
CICONIIFORMES					
Ardeidae					
Nycticorax nycticorax	Argentina (1)	1	5	0	Ault 1943
COLUMBIFORMES					
Columbidae					
Columbine talpacoti	Brazil (2)	1	0	0	Arzua and Barros-Battesti 1999
FALCONIFORMES					
Falconidae					
Phalcoboenus australis	Argentina (3)	1	2	37	USNTC[a]
Phalcoboenus australis	Argentina (4)	0	12	7	USNTC
GALLIFORMES					
Cracidae					
Oreophasis derbianus	Guatemala (1)	1	0	0	Arthur 1960
Penelope sp.	Brazil (5)	0	2	1	Barros-Battesti and Knysak 1999
Penelope superciliaris	Brazil (6)	0	2	0	Barros-Battesti and Knysak 1999
PASSERIFORMES					
Coerebidae					
Diglossa albilatera	Colombia (1)	0	0	2	USNTC
Emberizidae					
Trichothraupis melanops	Brazil (2)	0	1	0	Arzua and Barros-Battesti 1999
Zonotrichia capensis	Chile (5)	0	3	2	CDCP[b]
Zonotrichia vulcani	Costa Rica (5)	0	1	0	Tonn et al. 1963
Formicariidae					
Conopophaga lineata	Brazil (2)	0	1	1	Arzua and Barros-Battesti 1999
Thamnophilus caerulescens	Brazil (3)	5	0	0	Cooley and Kohls 1945
Thamnophilus ruficapillus	Brazil (3)	1	0	0	Cooley and Kohls 1945
Thamnophilus ruficapillus	Brazil (4)	1	0	0	Arzua and Barros-Battesti 1999
Fringillidae					
Atlapetes pallidinucha	Colombia (1)	0	7	19	USNTC
Atlapetes schistaceus	Colombia (1)	0	0	3	USNTC
Furnariidae					
Aphrastura spinicauda	Chile (2)	0	16	53	USNTC
Aphrastura spinicauda	Chile (4)	0	1	2	USNTC
Aphrastura spinicauda	Chile (6)	0	1	0	USNTC
Aphrastura spinicauda	Chile (5)	0	7	1	CDCP
Clibanornis dendrocolaptoides	Brazil (2)	0	1	0	Arzua and Barros-Battesti 1999
Cinclodes antarcticus	Chile (3)	1	0	0	Robbins et al. 2001
Cinclodes fuscus	Chile (4)	1	2	0	Robbins et al. 2001
Cinclodes fuscus	Peru (3)	1	0	0	Robbins et al. 2001
Cinclodes patagonicus	Argentina (2)	0	1	0	Robbins et al. 2001
Pygarrichas albogularis	Chile (5)	0	0	1	CDCP
Synallaxis ruficapilla	Brazil (1)	0	1	1	Arzua et al. 2003
Syndactyla rufosuperciliata	Brazil (2)	0	4	0	Arzua and Barros-Battesti 1999
Lcteridae					
Curaeus curaeus	Chile (1)	1	1	0	González-Acuña et al. 2004
Sturnella loyca	Argentina (6)	2	0	0	Nuttall 1916

Table 1. Continued.

Host	Country	F	N	L	Source
Motacillidae					
Pipit	Peru (4)	1	2	0	Arthur 1960, USNTC
Parulidae					
Basileuterus leucoblepharus	Brazil (2)	0	0	1	Arzua and Barros-Battesti 1999
Seiurus aurocapillus	Costa Rica (1)	0	0	1	Arnold 1970
Thraupidae					
Anisognathus igniventris	Perk (6)	1	0	0	Arthur 1960
Anisognathus lacrymosus	Colombia (1)	0	0	2	USNTC
Nephelornis oneilli	Peru (2)	1	0	0	USNTC
Tangara vassorii	Colombia (1)	0	0	1	USNTC
Thraupis cyanocephala	Colombia (2)	1	0	0	USNTC
Rhinocryptidae					
Scytalopus sp.	Venezuela (1)	0	0	5	Jones et al. 1972
Troglodytidae					
Troglodytes sp.	Chile (6)	1	1	0	USNTC
Troglodytes monticola?	Chile (6)	1	1	0	USNTC
Thryorchilus browni	Costa Rica (5)	1	1		Tonn et al. 1963
Turdidae					
"Thrush"	Peru (5)	1	0	0	Nuttall 1916
Catharus gracilirostris	Costa Rica (5)	0	0	2	Tonn et al. 1963
Catharus gracilirostris	Costa Rica (1)	0	0	1	Arnold 1970
Catharus gracilirostris	Costa Rica (4)	0	0	1	USNTC
Turdus sp.	Uruguay (1, 2)	8	11	0	Cassamagnaghi and Bianchi Bazerque (1951)
Turdus albicollis	Brazil (2)	1	0	0	Arzua and Barros-Battesti 1999
Turdus amaurochalinus	Brazil (2)	0	2	0	Arzua and Barros-Battesti 1999
Turdus falcklandii	Chile (4)	4	4	3	USNTC
Turdus nigrescens	Costa Rica (5)	0	0	1	Tonn et al. 1963
Turdus nigrescens	Costa Rica (1)	1	0	0	Arnold 1970
Turdus plebejus	Costa Rica (3)	0	0	2	Tonn et al. 1963
Turdus rufiventris	Brazil (2)	24	27	38	Arzua and Barros-Battesti 1999
Turdus rufiventris	Brazil (1)	4	8	6	Arzua et al. 2003
Tyrannidae					
Elaenia albiceps	Chile (5)	0	0	1	CDCP
Knipolegus nigerrimus	Brazil (3)	1	0	0	Cooley and Kohls 1945
PICIFORMES					
Picidae					
Colaptes rupicola	Peru (7)	1	0	0	Arthur 1960
PROCELLARIIFORMES					
Pelecanoididae					
Pelecanoides magellani	Argentina (5)	1	1	0	USNTC
INAMIFORMES					
Tinamidae					
Nothoprocta pentlandii	Peru (1)	2	1	0	Arthur (1960), USNTC

Numbers in parentheses alongside country names refer to localities listed in Table 2. F = female, N = nymph, L = larva.

[a]United States National Tick collection.

[b]Collection of Departamento de Ciencias Pecuarias, Chillán, Chile.

Table 2. Countries, administrative divisions, localities, and approximate coordinates for Nodes auritulus collections from birds.

Country	Administrative division	Locality	Coordinates	
				w
Argentina 1	Santa Cruz	Rio Gallegos	51°37′ S	69°13′
Argentina 2	Tierra del Fuego	Bahía Buen Suceso	54°49′ S	65°13′
Argentina 3	*Ibidem*	Bahía Crossley	54°47′ S	64°40′
Argentina 4	*Ibidem*	Isla Observatorio	54°38′ S	64°09′
Argentina 5	*Ibidem*	Puerto Cook	54°43′ S	64°15′
Argentina 6	*Ibidem*	San Sebastián	53°17′ S	68°28′
Brazil 1	Parana	Bosque Reinhard Maack	25°29′ S	49°16′
Brazil 2	*Ibidem*	Curitiba	25°26′ S	49°16′
Brazil 3	Rio de Janeiro	Serra do Itataia	22°29′ S	44°34′
Brazil 4	Rio Grande do Sul	Herval do Sul	32°00′ S	53°25′
Brazil 5	Sao Paulo	Cotia	23°36′ S	46°56′
Brazil 6	*Ibidem*	Serra da Cantareira	23°27′ S	46°38′
Chile 1	Región VIII	Ñuble	36°51′ S	72°02′
Chile 2	Región XII	Fuerte Bulnes	53°36′ S	70°55′
Chile 3	*Ibidem*	Isla Gonzalo	56°30′ S	68°44′
Chile 4	*Ibidem*	Isla Navarino	55°05′ S	67°40′
Chile 5	*Ibidem*	Puerto Williams	54°55′ S	67°36′
Chile 6	*Ibidem*	Punta Arenas	53°08′ S	70°56′
Colombia 1	Cauca	Parque Nacional Surace	02°11′ N	76°21′
Colombia 2	Cundinamarca	Zipacón	04°46′ N	74°23′
Costa Rica 1	Alajuela	Volcán Poas	10°12′ N	84°14′
Costa Rica 2	Cartago	Cartago E	09°51′ N	83°55′
Costa Rica 3	*Ibidem*	Volcán Turrialba	09°58′ N	83°54′
Costa Rica 4	Guanacaste	Tilarán NE	10°30′ N	84°56′
Costa Rica 5	San José	Cerro de la Muerte	09°48′ N	83°51′
Guatemala 1	San Marcos	Volcán Tajumulco	15°02′ N	91°55′
Peru 1	Cusco	Ocongate	13°27′ S	71°23′
Peru 2	Huanuco	Acomayo NNW	09°45′ S	76°04′
Peru 3	Junín	Cercapuquío	12°23′ S	75°19′
Peru 4	*Ibidem*	Junín	11°09′ S	76°00′
Peru 5	*Ibidem*	La Oroya	11°31′ S	75°56′
Peru 6	Puno	Limbani N	14°06′ S	69°42′
Peru 7	*Ibidem*	Limbani SSW	14°12′ S	69°44′
Uruguay 1	Cerro Largo		32°30′ S	54°30′
Uruguay 2	Lavalleja		33°48′ S	54°46′
Venezuela 1	Mérida	Tabay SE	08°37′ N	71°02′

albiceps, *Nephelornis oneilli*, *Pelecanoides magellani*, *Phalcoboenus australis*, *Pygarrichas albogularis*, *Tangara vassorii*, *Thraupis cyanocephala*, *Troglodytes* sp., *Turdus falcklandii* and *Zonotrichia capensis*.

The *I. auritulus* species group appears to have a disjunct distribution in the Neotropical Zoogeographic Region. One area of apparent endemism is located in southern South America (from 56° S to 51°S) and includes Punta Arenas, the Chilean type locality for *I. auritulus* (Neumann 1899). Others are located in

southern Brazil (25° S–22° S), south-central Peru (14°S–10° S) and Central America (10° N–15° N). Most Peruvian, Central American and Venezuelan collectionswere made at altitudes greater than 2000 m.

We found 51 species of birds infested with ticks of the *I. auritulus* group; the great majority of these (42) are passeriforms, especially members of the families Furnariidae and Turdidae. However, only three passeriforms – *A. spinicauda* (Furnariidae), *Turdus rufiventris* (Turdidae), and *A. pallidinucha* (Fringillidae), and one species of Falconiformes, *P. australis* (Falconiidae), accounted for the great majority of ticks collected, since 255 of 380 specimens were found on these four host.

Discussion

Additional *I. auritulus* specimens may shed light on whether perceived discontinuities in the distribution of this group are real or derived by heterogeneous sampling efforts. It is still unclear whether the morphological differences between tick specimens from the four endemic areas described above print to the existence of sibling species or are examples of intraspecific variation. To resolve this problem, renewed efforts should be made to collect *I. auritulus* throughout the Neotropics, but especially in Peru and Central America, in order to obtain critical morphological data and, perhaps most important, DNA sequences.

Specimens of *I. auritulus* are now known from birds in the orders Ciconiiformes, Columbiformes, Falconiformes, Galliformes, Passeriformes, Piciformes, Procellariiformes and Tinamiformes. *I. auritulus* has been described as a parasite of passeriform and galliform birds (Keirans and Clifford 1978; Barros-Battesti et al. 2003), and our results confirm the importance of passeriforms as hosts of this taxon. However, in the Neotropics, at least, galliforms do not appear to be major hosts, as evidenced by the fact that we were able collect of only six specimens on three galliform species (Table 1). Surprisingly, 59 ticks were collected from several falconid *P. australis*.

The three passeriforms and the single falconiform species that together account for most of our records are non-migratory, tree-nesting birds. On the other hand, the burrow-nesting *Cinclodes fuscus*, which ranges from the Fuegian and Cape Horn archipelagos to northern Colombia and Venezuela (Robbins et al. 2001), migrates from southern South America to central Argentina, southern Brazil and Uruguay, and may thereby serve as a bridge between *I. auritulus* populations over much of South America.

In the absence of detailed epidemiological surveys, it is too early to make definitive statements concerning host specificity in the *I. auritulus* group. An exception is the five-year study conducted by Arzua and Barros-Battesti (1999) in the Brazilian city of Curitiba, where most *I. auritulus* specimens were collected from passeriform birds of the family Turdidae, especially *Turdus rufiventris*. The range of *T. rufiventris* includes eastern and southern Brazil,

Bolivia, Paraguay, Uruguay and Central Argentina (Meyer de Schauensee 1982). This range is not as wide as to join the populations of *I. auritulus* in southernmost South America, Peru and Central America. However, other *Turdus* species in southern Brazil that are also parasitized by *I. auritulus*, such as *T. amaurochalinus* and *T. albicollis*, have a much broader range and may contribute to gene flow among widely separated *I. auritulus* populations. These and other aspects of the ecology of the *I. auritulus* species group await further research.

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