Interrelationship between Ectoparasites and Wild Rodents from Tijucas do Sul, State of Paraná, Brazil

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Sixteen species of ectoparasites were collected from 50 wild rodents, from August 1990 to August 1991, in an area of Araucaria augustifolia *forest, in the municipality of Tijucas do Sul, State of Paraná, Brazil. Ectoparasites infested 98% of the rodents, with the highest indices of infestation found in the dry-cool season. Species that occurred in single or multiple infestations were recorded. Ectoparasite/host associations were significant ($p<0.01$) for* Gigantolaelaps wolffsohni/Oryzomys nigripes, Polygenis pradoi/Oxymycterus *sp. and* Amblyopinus *sp./*Oxymycterus *sp. The following represent new host records:* Polygenis (Polygenis) tripus *from* Akodon serrensis *and* Hoplopleura sciuricola *from* Sciurus aestuans. *New geographic records are given for two species of flea and one sucking lice.*

Key words: ectoparasites - mites - fleas - sucking lice - staphylinid beetles - wild rodents

In Brazil, the greatest amount of information on ectoparasites of small wild mammals has been obtained from municipalities of the State of Minas Gerais: Viçosa (Whitaker Jr & Mumford 1977), Caratinga (Botelho 1978), Belo Horizonte (Linardi et al. 1984, Botelho & Linardi 1996), Juiz de Fora (Linardi et al. 1987), Tiradentes (Lopes et al. 1989) and Serra da Canastra National Park (Whitaker Jr & Dietz 1987), with simultaneous records of mites, fleas and lice. Other Brazilian records of ectoparasites on wild mammals include Ilha Grande, State of Rio de Janeiro (Guitton et al. 1986), Ilha de Maracá, State of Roraima (Linardi et al. 1991a) and Florianópolis, State of Santa Catarina (Linardi et al. 1991b).

Concerning Paraná, except for previous studies of Guimarães (1945), Ribeiro (1966/1967), and Barros and Baggio (1992) on mammal ticks, only the municipalities of Mandirituba and Foz do Iguaçu have been studied in relation to the simultaneous occurrence of ectoparasites, even though Barros-Battesti and Arzua (1997) have recently presented a list of ectoparasites from marsupials in some of this state's biomes.

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This study adds new information on ectoparasites from wild rodents in Paraná, in relation to the intensity and prevalence of infestation by host, the associations of ectoparasites, as well as the frequency of the ectoparasites on the respective hosts.

MATERIALS AND METHODS

The municipality of Tijucas do Sul is located in southern Paraná (25º 55' S, 45º 24' W), Curitiba uplands sub-region (Maack 1968), where in the past sub-tropical forests of *Auracaria augustifolia* were predominant. Today these forests are reduced to small patches forming mosaics with agriculture and stockbreeding areas. The area of study, located in the Panagro farm, is constituted by three woods separated among themselves by 12 year-old *Pinus elliotti* and forming a dividing strip of 500 to 1,000 m^2.

The wild rodents were captured in an isolated wood of altered primary forest with strong regeneration. From August 1990 to August 1991, during eight field phases, 30 live traps baited with corn and peanut paste were used, for three consecutive nights/phase, for a total of 720 traps/night capture effort. The capture success was 6.9%. After anesthetizing with ether, ectoparasites were recovered from the rodents by combing and brushing. Tweezers were used when necessary. After preservation in 70º ethanol, they were mounted on slides for taxonomic identification.

Although exhibiting an ample spectrum of ecological adaptations, some Cricetidae present similar morphological characters. For this reason, ro-

dents were karyotyped to provide precise host identification. Chromosomes were obtained from bone marrow using Ford and Hamerton´s (1956) technique. G-banding was obtained by trypsin treatment (Seabright 1971) with some modifications reported by Sbalqueiro and Nascimento (1996).

The ectoparasite-host association was evaluated by the c^2 test. Significant associations were also analyzed by the coefficient of interspecific association (C), expressed in Southwood (1971). For each pair of species, the quantitative values ranging from +1 (complete positive association) to -1 (complete negative association) permit comparisons among different ectoparasite host associations. Two species ***A*** and ***B***, compared in a 2 x 2 contingency table give the following alternatives: (***a***) presence of both species; (***b***) presence of A and absence of B; (***c***) absence of A and presence of B; (***d***) absence of both species. In ***n*** samples, when ***ad*** is greater than ***bc*** the association is positive, with the coefficient and respective standard error being calculated by the formula:

$$C_{AB} = \frac{ad - bc}{(a+b)(b+d)} \pm \sqrt{\frac{(a+c)(c+d)}{n(a+b)(b+d)}}$$

The indices of infestation for Acari and Siphonaptera were calculated by the arithmetic mean to stipulate the infestation dimension in the studied area.

Representative specimens of ectoparasites and skins and skulls of hosts were deposited in the Museu de História Natural Capão da Imbuia, Curitiba, Paraná, Brazil. Prostigmata and Astigmata mites were not surveyed in the present work, but the skin collection of the museum represents future research opportunities.

RESULTS AND DISCUSSION

In total, 885 ectoparasite specimens representing 16 species were taken from 50 cricetid rodents. Rhopalopsyllinae Siphonaptera nomenclature follows the proposal of Linardi and Guimarães (1993).

Except for *Sciurus aestuans* L. and *Nectomys squamipes* (Brants), the other cricetid species presented the following karyotypes, whereas NA means number of autosomal arms: *Akodon* sp. (2n=44/NA=44), *Akodon montensis* (Thomas) (2n=24/NA=42), *Akodon serrensis* (Thomas) (2n=46/NA=46), *Bolomys lasiurus* (Lund) (2n=34/NA=34), *Oryzomys flavescens* (Waterhouse) (2n=64/NA=66), *Oryzomys nigripes* (Olfers) (2n=62/NA=82) and *Oxymycterus* sp. (2n=54/NA=64).

Species of ectoparasites and their respective hosts are shown in Table I. Comparing the results with those previously found for the municipalities of Mandirituba and Foz do Iguaçu (Barros et al. 1993) it can be seen that, while the mean intensity of ectoparasites is similar to that of the two municipalities (17.7), the total prevalence is higher, reaching almost all of the captured rodents (98%).

For Siphonaptera, *Polygenis rimatus* was the most abundant, with 33% of the total of fleas collected in 32% of rodents, being more frequent on *A. serrensis* (57%) and *Oxymycterus* sp. (37%) (Tables I, II). Except for *Polygenis tripus*, whose geographical distribution includes caatinga scrub, steppe, savanna and Atlantic forest areas, the other flea species are common in *A. angustifolia* forests (Linardi 1987).

The Parasitiformes acari infestation was dominant when compared to other ectoparasite groups. *Androlaelaps rotundus* was the most frequently occurring species among 748 acari (55%), occurring on 52% of the rodents (Tables I, II), with *A. serrensis* the most infested host: 78% (Table I). Previous studies have shown *A. rotundus* at a prevalence of 93.5% on *A. arviculoides* (Linardi et al. 1987), 71.4% on *A. cursor* (Linardi et al. 1991b), and in all *A. serrensis* captured (Barros et al. 1993). The specimens of *Amblyomma* (Ixodidae) were not identified accurately for they are immature. The three larva and one nymph were similar to the description of *A. cajennense* reported by Amorim and Serra-Freire (1996). Horses usually infested with this tick were, sometimes, observed in the trails between the woods. Although the specimens of Macronyssidae mites are similar to ones in the genus *Lepronyssoides*, here they were only listed by the family.

Amblyopinus sp. were more frequent on *Oxymycterus* sp. (62%), with few examples captured on *Akodon* species (Table I). Amblyopinini species are common on rodents and marsupials, although they also occur on bats and sloths (Seevers 1955, Timm & Ashe 1987) and are difficult to differentiate at the species' level. Ashe and Timm (1987) consider Amblyopinini as mutualists, instead of true parasites. In the present study, the specimens only occurred during the cold-dry season being more collected over their hosts hair than fixed. Specimens of *Amblyopinus* sp. on rodents from the Juréia Ecological Station, State of São Paulo, were collected by Bergallo (1991) mainly during the dry season. This author observed that the specimens had their mandibles fixed on their hosts hair base without, in spite of that, causing skin bruises.

The rodent species diversity and frequencies during the months of study are listed in Table III. Except for October 1990 and March 1991, *Oxymycterus* sp. was captured in all months, at the

TABLE I

Ectoparasites collected on 50 wild rodents from Tijucas do Sul, State of Paraná, Brazil, from August 1990 to August 1991

	Examined rodents								
	Akodon sp. $n_1 = 4$	*Akodon montensis* $n_1 = 4$	*Akodon serrensis* $n_1 = 14$	*Oryzomys flavescens* $n_1 = 1$	*Oryzomys nigripes* $n_1 = 9$	*Oxymycterus* sp. $n_1 = 16$	*Nectomys squamipes* $n_1 = 1$	*Sciurus aestuans* $n_1 = 1$	Total $n_1 = 50$
	No. % *n*	No. % *n*	No. % *n*	No. % *n*	No. % *n*	No. % *n*	No. % *n*	No. % *n*	No. % ***n***
Acari	3 (75) 34	4 (100) 48	13 (93) 400	1 (100) 3	9 (100) 49	10 (62) 209	1 (100) 4	1 (100) 1	42 (84) 748
Amblyomma aff. cajennense	-	-	-	-	-	-	1 (100) 4	-	1 (2) 4
Androlaelaps fahrenholzi (Berlese)	1 (25) 7	1 (25) 2	12 (86) 86	-	1 (11) 7	9 (56) 60	-	1 (100) 1	25 (50) 163
Androlaelaps rotundus (Fonseca)	3 (75) 27	4 (100) 45	11 (78) 314	1 (100) 1	4 (44) 11	3 (19) 16	-		26 (52) 414
Gigantolaelaps wolffsohni (Oudemans)	-	-	-	1 (100) 2	6 (67) 11	-	-	-	7 (14) 13
Laelaps paulistanensis (Fonseca)	-	-	-	-	4 (44) 13	-	-	-	4 (8) 13
Mysolaelaps parvispinosus (Fonseca)	-	-	-	-	3 (33) 7	-	-	-	3 (6) 7
Macronyssidae	-	1 (25) 1	-	-	-	5 (31) 133	-	-	6 (12) 134
Anoplura	-	-	1 (7) 8	-	-	-	-	1 (100) 3	2 (4) 11
Hoplopleura sciuricola Ferris	-	-	-	-	-	-	-	1 (100) 3	1 (100) 3
Hoplopleura imparata Linardi, Teixeira & Botelho	-	-	1 (7) 8	-	-	-	-	-	1 (7) 8
Coleoptera	1 (25) 1	1 (25) 3	1 (7) 1	-	-	10 (62) 30	-	-	13 (26) 35
Amblyopinus sp.	1 (25) 1	1 (25) 3	1 (7) 1	-	-	10 (62) 30	-	-	13 (26) 35
Siphonaptera	3 (75) 5	3 (75) 6	10 (71) 24	1 (100) 1	2 (22) 2	12 (75) 49	-	1 (100) 4	32 (64) 91
Craneospylla minerva (Rothchild)	2 (50) 2	2 (50) 3	1 (7) 1	1 (100) 1	1 (11) 1	3 (19) 5	-	-	10 (20) 13
Polygenis occidentalis (Cunha)	-	-	-	-	-	-	-	1 (100) 4	1 (2) 4
Polygenis pradoi (Wagner)	1 (25) 1	1 (25) 2	1 (7) 1	-	-	7 (44) 12	-	-	10 (20) 16
Polygenis pygaerus (Wagner)	1 (25) 1	1 (25) 1	4 (28) 6	-	-	7 (44) 19	-	-	13 (26) 27
Polygenis rimatus (Jordan)	1 (25) 1	-	8 (57) 15	-	1 (11) 1	6 (37) 13	-	-	16 (32) 30
Polygenis tripus (Jordan)	-	-	1 (7) 1	-	-	-	-	-	1 (2) 1
Total	4 (100) 40	4 (100) 57	14 (100) 433	1 (100) 4	9 (100) 51	15 (94) 288	1 (100) 4	1 (100) 8	49 (98) 885

n_1**:** number of hosts examined; *n*: number of ectoparasites collected; No.: number of infested rodents.

TABLE II

Number and (%) of Acari and Siphonaptera collected between 1990 and 1991 in Tijucas do Sul, State of Paraná, Brazil

	Months								
	Aug'90	Oct'90	Nov'90	Dec'90	Mar'91	Apr'91	Jun'91	Aug'91	Total
Acari	59 (8)	48 (6)	179 (24)	84 (11)	9 (1)	302 (40)	37 (5)	30 (4)	748 (89)
Amblyomma aff. cajennense	-	-	-	-	-	-	4 (100)	-	4 (1)
Androlaelaps fahrenholzi	19 (12)	4 (2)	12 (7)	9 (6)	-	106 (65)	13 (8)	-	163 (22)
Androlaelaps rotundus	32 (8)	44 (11)	136 (33)	-	-	168 (40)	20 (5)	14 (3)	414 (55)
Gigantolaelaps wolfhsoni	2 (15)	-	-	-	3 (23)	-	-	8 (62)	13 (2)
Laelaps paulistanensis	3 (23)	-	-	-	6 (46)	-	-	4 (31)	13 (2)
Mysolaelaps parvispinosus	3 (43)	-	-	-	-	-	-	4 (57)	7 (1)
Macronyssidae	-	-	31 (23)	75 (56)	-	28 (21)	-	-	134 (18)
Siphonaptera	9 (10)	4 (4)	7 (7)	12 (13)	-	33 (36)	13 (15)	13 (15)	91 (11)
Craneopsylla minerva	5 (39)	-	-	1 (8)	-	2 (15)	3 (23)	2 (15)	13 (14)
Polygenis occidentalis	-	-	4 (100)	-	-	-	-	-	4 (4)
Polygenis pradoi	1 (6)	2 (13)	-	3 (18)	-	6 (37)	2 (13)	2 (13)	16 (18)
Polygenis pygaerus	-	1 (4)	1 (4)	3 (11)	-	13 (48)	3 (11)	6 (22)	27 (30)
Polygenis rimatus	3 (10)	1 (3)	1 (3)	5 (17)	-	12 (40)	5 (17)	3 (10)	30 (33)
Polygenis tripus	-	-	1 (100)	-	-	-	-	-	1 (1)
Total	68 (8)	52 (6)	186 (22)	96 (12)	9 (1)	335 (40)	50 (6)	43 (5)	839 (100)

TABLE III

Number and (%) of rodents captured between 1990 and 1991 in Tijucas do Sul, State of Paraná, Brazil

	Months								
Species	Aug'90	Oct'90	Nov'90	Dec'90	Mar'91	Apr'91	Jun'91	Aug'91	Total
Akodon sp.	-	-	-	-	-	1	1	2	4 (8%)
Akodon montensis	1	1	1	-	-	-	1	-	4 (8%)
Akodon serrensis	3	2	3	-	-	6	-	-	14 (28%)
Oryzomys flavescens	-	-	-	-	-	-	-	1	1 (2%)
Oryzomys nigripes	2	-	-	-	1	-	-	6	9 (18%)
Oxymycterus sp.	2	-	1	2	-	3	3	5	16 (32%)
Nectomys squamipes	-	-	-	-	-	-	1	-	1 (2%)
Sciurus aestuans	-	-	1	-	-	-	-	-	1 (2%)
Total	8 (16%)	3 (6%)	6 (12%)	2 (4%)	1 (2%)	10 (20%)	6 (12%)	14 (28%)	50 (100%)

frequency of 32%, with the greatest number of captures in August 1991.

The following results were significant by the application of the c^2 test ($p<0.01$) and positive coefficient of interspecific association ($C>0.50$); the results were significant for the following associations: *Gigantolaelaps wolffsohni*/*Oryzomys nigripes* (c^2 = 20.23; C = 0.83 ± 0.16*), Polygenis pradoi*/*Oxymycterus* sp. (c^2 = 6.25; C = 0.55 ± 0.19) and *Amblyopinus* sp./*Oxymycterus* sp. (c^2 = 13.62; C = 0.62 ± 0.47). According to Botelho et al. (1981), these values support the recognition of the true hosts for those ectoparasites in a given study area. These results allied with the kariology constitute an important step for correct host identifications.

According to Table II, both the infestations by acari and fleas were higher in April 1991, with the number of infested rodents decreasing from that month on. Grouping the months in seasons (cold-dry: August 1990, April 1991, June 1991, August 1991; warm-rainy: October 1990, November 1990, December 1990 and March 1991) it can be seen that the total of captured ectoparasites was greater in the cold-dry season, both for fleas and acari (Tables II, IV). Nevertheless, while the percentages for acari were, respectively, 57.2% (cold-dry) and 42.7% (warm-rainy), fleas showed a three fold increase in abundance in the cold-dry season: 74.7% against 25.3% in the warm-rainy season. Relative to the infestation prevalence, fleas and acari showed different results concerning the number of infested rodents in both seasons, with acari being more prevalent in the warm-rainy season (100%) and fleas in the cold-dry season (65.8%). Anoplura and Coleoptera, when compared in relation to seasonality, showed alternate distribution, with *Hoplopleura* species found only in the warm-rainy period and *Amblyopinus* in the cold-dry one (Table IV).

The association between ectoparasites indicated in Table V show the prevalence of double infestations being most common and simple, triple and quadruple ones nearly equivalent in number. By host, the most common infestations were: simple on *O. nigripes*; double, quintuple and sextuple on *Oxymycterus* sp.; triple and quadruple on *A. serrensis*.

New geographical and host records were found during this work: (a) *Hoplopleura sciuricola*, found for the second time in Brazil. In the Oswaldo Cruz Collection, a specimen from Caraguatatuba, State of São Paulo (without date and host record) was identified by Werneck. Previous studies have indicated this species occurrence in the United States, Venezuela, Colombia, Peru and Bolivia (Ferris 1951, Johnson 1972); (b) *Sciurus aestuans*,

TABLE IV

Monthly prevalences of ectoparasites on wild rodents from Tijucas do Sul, State of Paraná, Brazil, and total indices of Acari and Siphonaptera

Months	Rodents	Total			Acari		Total	Siphonaptera		Total	Coleoptera		Total	Anoplura		Total	Total Indices
		No.	%	n	No.	%	n	No.	%	n	No.	%	n	No.	%	n	Acari / Siphonaptera
Aug'90	8	8	100	79	8	100	59	6	75	9	3	38	11		-	-	7.4 / 1.1
Oct'90	3	3	100	60	3	100	48	2	67	4		-	-	1	33	8	16.0 / 1.3
Nov'90	6	6	100	189	6	100	179	3	50	7		-	-	1	17	3	29.8 / 1.2
Dec'90	2	2	100	96	2	100	84	2	100	12		-	-		-	-	42.0 / 6.0
Mar'91	1	1	100	9	1	100	9		-	-		-	-		-	-	9 / -
Apr'91	10	10	100	337	9	90	302	10	100	33	2	20	2		-	-	30.2 / 3.3
Jun'91	6	6	100	60	5	83	37	4	67	13	3	50	10		-	-	6.2 / 2.2
Aug'91	14	13	93	55	8	57	30	5	35	13	5	36	12		-	-	2.1 / 0.9
Total	50	49	98	885	42	84	748	32	64	91	13	26	35	2	4	11	15.0 / 1.8

No.: number of rodents infested; n: number of ectoparasites.

TABLE V

Simple and multiple infestations of ectoparasites on wild rodents from Tijucas do Sul, State of Paraná, Brazil

Infestation	Ectoparasites (No.)	Hosts (No.)	Infestation	Ectoparasites (No.)	Hosts (No.)
Simple: (8)	a (1)	G (1)		b - c - o (2)	C (2)
	j (1)	F (1)		b - c - p (1)	C (1)
	c (3)	C (1) - E (2)		b - c - n (1)	C (1)
	d (2)	E (1)		b - h - l (1)	H (1)
	o (1)	C (1)		b - n - o (1)	C (1)
Double: (16)	j - b (1)	F (1)		c - d - k (1)	D (1)
	j - m (2)	F (2)	Quadruple: (9)	j - c - m - n (1)	F (1)
	j - n (1)	F (1)		j - c - n - o (1)	A (1)
	j - o (1)	F (1)		b - c - i - o (1)	C (1)
	b - c (3)	A (1) - C (2)		b - c - m - n (1)	C (1)
	b - g (1)	F (1)		b - c - m - o (1)	C (1)
	c - g (1)	B (1)		b - c - n - o (1)	C (1)
	c - k (2)	A (1) - B (1)		b - g - m - o (1)	F (1)
	c - d (1)	E (1)		b - g - n - o (1)	F (1)
	d - e (1)	E (1)		d - e - f - k (1)	E (1)
	e - f (1)	E (1)	Quintuple: (3)	j - b - c - n - o (2)	A (1) - F (1)
	k - m (1)	A (1)		b - c - g - m - n (1)	F (1)
Triple: (10)	j - c - k (1)	B (1)	Sextuple: (3)	j - b - k - m - n - o (1)	F (1)
	j - b - k (1)	F (1)		b - c - d - e - f - o (1)	E (1)
	b - c - k (1)	C (1)		b - g - k - m - n - o (1)	F (1)

Legend

Ectoparasites

Acari

a *Amblyomma aff. cajennense*
b *Androlaelaps fahrenholzi*
c *Androlaelaps rotundus*
d *Gigantolaelaps wolffsohni*
e *Laelaps paulistanensis*
f *Mysolaelaps parvispinosus*
g Macronyssidae

Anoplura

h *Hoplopleura sciuricola*
i *Hoplopleura imparata*

Coleoptera

j *Amblyopinus* sp.

Siphonaptera

k *Craneopsylla minerva*
l *Polygenis occidentalis*
m *Polygenis pradoi*
n *Polygenis pygaerus*
o *Polygenis rimatus*
p *Polygenis tripus*

Hosts

A *Akodon* sp.
B *Akodon montensis*
C *Akodon serrensis*
D *Oryzomys flavescens*
E *Oryzomys nigripes*
F *Oxymycterus* sp.
G *Nectomys squamipes*
H *Sciurus aestuans*

for the first time notified as *H. sciuricola* host, although other species of the same genus can be infested by this louse (Ferris 1951, Johnson 1972); (c) *Polygenis* (*P.*) *o. occidentalis* and *Polygenis* (*N.*) *pygaerus*, although both coexist in Santa Catarina; (d) *A. serrensis* parasited by *Polygenis* (*P.*) *tripus*.

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