

Parasitic Arthropods of Some Wild Rodents from Juréia-Itatins Ecological Station, State of São Paulo, Brazil

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A study of the associations between three species of rodents in the Atlantic forest and their parasitic arthropods was undertaken at the Juréia-Itatins Ecological Station, located in the State of São Paulo, Southeastern Brazil, from March 1989 to February 1990. Individuals of three species, Oryzomys russatus, Proechimys iheringi and Nectomys squamipes were captured and examined for ectoparasites. Eleven species of parasitic arthropods were found, including four species of insects and seven of Acari. Parasitism intensity, phenology, and rainfall were positively correlated with the abundance of the ectoparasites and their hosts. The most abundant host was O. russatus (Muridae: Sigmodontinae), and the most common parasite on it was the laelapid mite Gigantolaelaps oudemansi. The cuterebrid Metacuterebra apicalis caused myiasis in O. russatus. A mutualistic association between the staphylinid beetle Amblyopinus sp. and its host P. iheringi (Echimyidae) was observed. The few N. squamipes captured had small numbers of ectoparasites.

Key words: rodent ectoparasites - Acari - Diptera - Siphonaptera - Coleoptera - Atlantic rain forest - Brazil

Ectoparasitic arthropods that infest mammals are either insects or acarines (Kettle 1985). Some ectoparasites such as chewing and sucking lice are permanent, whereas most adult fleas and ticks are temporary (Kim 1985). Some ectoparasites are biological vectors of pathogenic organisms (viruses, bacteria, protozoans, and helminths) among their hosts (Kettle 1985).

Some studies that have examined ectoparasites of small mammals in the Brazilian Atlantic forest (Fonseca 1939a, Guimarães 1945, Linardi 1977, Linardi et al. 1984, 1987, 1991, Guitton et al. 1986, Barros & Baggio 1992, Bossi & Bergallo 1992, Barros et al. 1993, Carvalho et al. 2001) have included species inventories, taxonomic descriptions, and records of host-parasite associations. Others (Botelho et al. 1981, Barros-Battesti et al. 1998) have evaluated the ectoparasites-host associations. The objectives of the present study were to (1) describe the relationship between three Atlantic forest rodent species and their ectoparasites; (2) assess the degree of host ectoparasite specificity; and (3) examine the influence of rainfall on ectoparasite abundance.

MATERIALS AND METHODS

The present study was undertaken at the Juréia-Itatins Ecological Station (24°32'S; 47°15'W), located in the municipalities of Peruíbe, Iguape, Miracatu and Itariri, State of São Paulo, Southeastern Brazil. The climate is tropical humid, with a mild, dry season from May to September.

Annual rainfall is high (3,000 to 4,000 mm/yr) (Paixão 1984). During the present study, the wettest month was January 1990 (546.3 mm), and the driest was August 1989 (49 mm). For data analysis, the dry and cool period was considered to range from April to September and the wet and warm period from October to March. The mean temperature varies from 18.3°C to 25.6°C, with July being the coolest month and February the warmest (Nascimento & Pereira 1988).

Field samples were obtained monthly from February 1989 to March 1990. Small mammal trapping was conducted in an irregular grid covering 5 ha, with 14 transects varying from 200 to 240 m, spaced 20-m apart. Wire-cage traps (120) baited with banana or manioc with peanut butter were set on the forest floor for three consecutive nights (Bergallo 1994). Each trap site was recorded and trapped animals were taken to a nearby station laboratory. Handling of small mammals was similar to the procedure used by Gettinger (1992). The animals were placed in plastic bags with a cotton ball soaked with ethyl ether until they became unconscious, after which they were marked using an ear-code (Monteiro-Filho 1987), weighed, and sexed. Larger ectoparasites were removed from the fur, ears and tail with fine combs, toothbrushes or tweezers and stored in 70% alcohol. The hosts were subsequently released at the same trap site. Ectoparasites that fell from the animals during anesthesia in the plastic bag were also stored in 70% alcohol.

Analysis of variance was used to test the effect of host species, parasite species and period of the year (dry or wet) on parasite prevalence. Comparisons of parasite relative densities versus host sex were done using Student's *t*-test. In addition to these analyses, prevalence and mean intensity were determined for the most common species. Prevalence is defined as the number of hosts infested with one or more individuals of a particular parasite species or taxonomic group divided by the number of hosts examined for that parasite. Mean intensity is the

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total number of parasites of a particular species found in a sample divided by the number of hosts infested with that parasite (Bush et al. 1997). Overall host and parasite abundances by period of the year (dry or wet) were also analyzed using ANOVA. The analyses were done using the SAS statistical program (SAS Institute 1987).

RESULTS

A total of 5,350 arthropods specimens infesting 11 species was taken from 80 small rodents, 23 being the spiny rat *Proechimys iheringi* Thomas, 51 the rice rat *Oryzomys russatus* (Wagner) and 6 the water rat *Nectomys squamipes* (Brants). In addition to the rodents, three species of marsupials: *Didelphis aurita* Wied-Neuwied, *Metachirus nudicaudatus* (Desmarest), and *Philander frenata* (Linnaeus) were captured, and the results will be presented elsewhere.

Ectoparasites collected were Acari Ixodidae: *Amblyomma cajennense* (Fabricius), *Haemaphysalis leporispalustris* (Packard) and *Ixodes* sp.; Acari Lelapidae: *Gigantolaelaps oudemansi* Fonseca, *Androlaelaps (Haemolaelaps) sp.*, *Gigantolaelaps gilmorei* Fonseca; Siphonaptera Rhopalopsyllidae: *Polygenis (Polygenis) roberti roberti* (Rothschild); Siphonaptera Ctenophthalmidae: *Adoratopsylla (Tritopsylla) intermedia intermedia* (Wagner); Diptera Cuterebridae: *Metacuterebra apicalis* (Guérin-Meneville); Coleoptera Staphylinidae: *Amblyopinus* sp. Siphonaptera nomenclature

is according to the one proposed by Linardi and Guimarães (2000).

Seven arthropod species, totaling 5,148 individuals, were collected from 139 captures of *O. russatus*. This represented 96.2% of the ectoparasites collected from all hosts. *G. oudemansi* was the most frequent species (3,162 individuals), and was collected almost exclusively on *O. russatus*. *A. (Haemolaelaps) sp.* (n = 550) was collected exclusively on *O. russatus*. *G. gilmorei* (n = 717), *P. r. roberti* (n = 155), *M. apicalis*, a subcutaneous parasite (n = 25), and *Ixodes* sp. (n = 12), were also collected almost exclusively on *O. russatus*, but with a frequency much lower than that recorded for *G. oudemansi* (Table I). Other ectoparasites collected on *O. russatus* included 12 nymphs and 505 larvae of *A. cajennense*.

A total of 202 individuals, belonging to 11 species of arthropods was captured from 75 captures of *P. iheringi*, representing 3.8% of all arthropods collected on the hosts. The beetle *Amblyopinus* sp. (n = 80), a mutualistic insect, was collected almost exclusively on this rodent. Twelve *Androlaelaps* sp., and 3 *H. leporispalustris* were collected exclusively on *P. iheringi*. Other ectoparasites collected on this host included *A. cajennense* (larvae: n = 67); nymphs: (n = 15), *G. oudemansi* (n = 12), *G. gilmorei* (n = 4), *Ixodes* sp. (n = 3), *P. r. roberti* (n = 5) and *A. i. intermedia* (n = 2) (Table I).

Only 8 arthropods of 4 species (0.2% of all specimens) were collected on *N. squamipes*, including *G. oudemansi*

TABLE I

Relative density of arthropods recovered from 139 *Oryzomys russatus*, 75 *Proechimys iheringi* and 11 *Nectomys squamipes* at the Juréia-Itatins Ecological Station, State of São Paulo, Brazil, March 1989-February 1990

Oryzomys russatus

Ectoparasites	Dry months	(N)	Wet months	(N)	DF	t	P
<i>A. cajennense</i> (nymphs)	0.89	(2)	0.81	(7)	7	0.51	0.6263
<i>A. cajennense</i> (larvae)	1.13	(3)	0.69	(3)	2	1.66	0.2384
<i>G. gilmorei</i>	1.63	(41)	1.73	(67)	673	0.67	0.5039
<i>G. oudemansi</i>	2.43	(73)	2.45	(131)	205	0.14	0.8888
<i>A. (Haemolaelaps) sp.</i>	1.65	(32)	1.67	(49)	79	0.14	0.8903
<i>Ixodes</i> sp.	0.75	(7)	0.69	(4)	6	1.0	0.3559
<i>M. apicalis</i>	0.69	(6)	0.91	(12)	11	2.64	0.0229
<i>P. r. roberti</i>	1.07	(26)	1.21	(34)	571	1.26	0.2128

Proechimys iheringi

Arthropods	Dry months	(N)	Wet months	(N)	DF	t	P
<i>A. cajennense</i> (nymphs)	0.69	(2)	0.81	(10)	9	1.96	0.0811
<i>A. cajennense</i> (larvae)	1.16	(5)	1.40	(12)	15	0.63	0.5388
<i>Amblyopinus</i> sp.	1.17	(21)	0.94	(13)	32	1.36	0.1824
<i>G. oudemansi</i>	1.66	(2)	0.92	(3)	3	2.04	0.1343
<i>H. leporispalustris</i>	0.69	(2)	-	(1)	-	-	-
<i>P. r. roberti</i>	0.69	(3)	0.69	(1)	-	-	-

Nectomys squamipes

Arthropods	Dry months (N)	Wet months (N)	DF	t	P
<i>A. cajennense</i> (larvae)	(0)	(2)	-	-	-
<i>Amblyopinus</i> sp.	(0)	(1)	-	-	-
<i>G. oudemansi</i>	(0)	(4)	-	-	-
<i>M. apicalis</i>	(0)	(1)	-	-	-

A: *Amblyomma*; G: *Gigantolaelaps*; A: *Androlaelaps*; M: *Metacuterebra*; P.r.: *Polygenis roberti*; N: number of observations; DF: degrees of freedom; t: t-test values; P: probabilities

(n = 4), *A. cajennense* larvae (n = 2), *Amblyopinus* sp. (n = 1) and *M. apicalis* (n = 1).

There was no significant relationship between parasite intensity and host sex for any host species. The mean parasite intensities were, respectively, 1.90 and 1.77, on male and female *O. russatus* ($t_{498} = 1.27$; $P = 0.20$), and 0.97 and 1.10 on male and female *P. iheringi* ($t_{572} = 1.17$; $P = 0.24$).

The relationship between parasite intensity and period of the year (dry or wet) was significant only for *O. russatus*, with higher values in the wet (1.95) than in the dry (1.72) period ($t_{498} = 2.58$; $P < 0.01$). Parasite intensity on *P. iheringi* during the dry (1.11) and wet (0.96) months did not differ significantly ($t_{88} = 1.39$; $P = 0.16$). *N. squamipes* was captured with ectoparasites only during wet months.

The relationship between the mean numbers of arthropods and the period of the year was significantly different for *M. apicalis* found on *O. russatus* (Table I).

The mean intensity of parasitic arthropods during the wet and dry months was significantly different only for *M. apicalis* (Table II). This parasite showed a higher intensity of parasitism during the wet period.

Comparisons of the mean intensities among arthropod species were significant for the hosts *O. russatus* ($F = 57.39$; $P = 0.0001$) and *P. iheringi* ($F = 2.28$; $P = 0.0181$) (Table III). *N. squamipes* had too few parasites for meaningful statistical analysis. No lice were collected.

DISCUSSION

The type of traps used in this work did not prevent the ectoparasites from abandoning their hosts. This could have occurred with specimens of *Amblyopinus* sp., which some species normally remain on the host only at night (Ashe & Timm 1987). Using combs, toothbrushes or tweezers to sample the hosts could account for the absence of lice in samples, since these ectoparasites usually remain firmly attached to the host. In addition, it was not possible to determine the exact area of the host body where most of the ectoparasites were collected. Bots of *M. apicalis* were located on the lateral thoracic region and

TABLE III

Total number of arthropods found on *Oryzomys russatus* and *Proechimys iheringi* at the Juréia-Itatins Ecological Station, State of São Paulo, Brazil, March 1989-February 1990. The Table shows the number of observations (N) and the mean density per host and standard deviation (SD) of parasite intensities

Oryzomys russatus

Arthropods	N	Mean density ^a	SD	Duncan test ^b
<i>G. oudemansi</i>	207	2.44	1.00	A
<i>G. gilmorei</i>	108	1.70	0.74	B
<i>A. (Haemolaelaps) sp.</i>	81	1.67	0.87	B
<i>P. roberti</i>	60	1.15	0.45	B/C
<i>A. cajennense</i> (larvae)	6	0.91	0.38	C
<i>M. apicalis</i>	7	0.90	0.28	C
<i>A. cajennense</i> (nymphs)	9	0.82	0.20	C
<i>Ixodes sp.</i>	11	0.73	0.12	C

Proechimys iheringi

Arthropods	N	Mean density ^a	SD	Duncan test ^b
<i>A. cajennense</i> (larvae)	17	1.33	0.71	A
<i>G. oudemansi</i>	5	1.22	0.53	A
<i>Amblyopinus sp.</i>	34	1.08	0.46	A
<i>Androlaelaps sp.</i>	8	0.89	0.21	A
<i>A. cajennense</i> (nymphs)	12	0.79	0.18	A
<i>G. gilmorei</i>	2	0.69	0	A
<i>H. leporispalustris</i>	3	0.69	0	A
<i>A. intermedia</i>	2	0.69	0	A
<i>Ixodes sp.</i>	3	0.69	0	A
<i>P. r. roberti</i>	2	0.69	0	A
<i>M. apicalis</i>	1	0.69	-	-

A: *Amblyoma*; A: *Androlaelaps*; G: *Gigantolaelaps*; H: *Haemaphysalis*; M: *Metacutereba*; P.r.: *Polygenis roberti*; a: Log₁₀ of the frequency; b: means followed by the same letter, did not differ significantly at the 5% overall level of probability, when Duncan's multiple comparisons test was used; N: number of observations; DF: degrees of freedom

TABLE II

Mean numbers of parasitic arthropods collected from three different rodent hosts at the Juréia-Itatins Ecological Station, State of São Paulo, Brazil, March 1989-February 1990

Arthropods	Dry months (N) ^a	Wet months (N) ^a	DF	t	P		
<i>A. cajennense</i> (nymphs)	0.79	(4)	0.81	(17)	19	0.17	0.8689
<i>A. cajennense</i> (larvae)	1.15	(8)	1.26	(15)	21	0.38	0.7086
<i>Amblyopinus sp.</i>	0.94	(21)	0.72	(13)	32	1.36	0.1824
<i>A. (Haemolaelaps) sp.</i>	1.65	(32)	1.68	(49)	79	0.14	0.8900
<i>G. gilmorei</i>	1.63	(41)	1.71	(69)	67.8	0.48	0.6341
<i>G. oudemansi</i>	2.41	(78)	2.42	(134)	210	0.05	0.9641
<i>H. leporispalustris</i>	0.69	(2)	0.69	(1)	-	-	-
<i>Ixodes sp.</i>	0.75	(7)	0.69	(7)	6	1.00	0.3559
<i>M. apicalis</i>	0.69	(6)	0.91	(12)	11	2.64	0.0229
<i>P. r. roberti</i>	1,03	(29)	1,20	(35)	59.7	1.52	0.1338

A: *Amblyoma*; A: *Androlaelaps*; G: *Gigantolaelaps*; H: *Haemaphysalis*; M: *Metacutereba*; P.r.: *Polygenis roberti*; a: Log₁₀ of the frequency; N: number of observations; DF: degrees of freedom; t: t-test values; P: probabilities

neck (Bossi & Bergallo 1992), and the beetles *Amblyopinus* sp., were attached to the base of the tail.

O. russatus was the most abundant host and also had the highest prevalence of ectoparasites. *G. oudemansi*, the most commonly collected ectoparasite, was recovered almost exclusively from *O. russatus*. According to Gettinger (1987), species of *Gigantolelaps* are restricted to the genus *Oryzomys*. Only one species of flea, *P. r. roberti*, parasitized this host, and showed a strong association with *O. russatus*, since 98.1% of the fleas were found on this host. According to Linardi (1984), *Oryzomys* is the main host genus for *P. r. roberti*. Larvae of *M. apicalis* were found on *O. russatus*. Although this parasite is large compared to the host, apparently it did not affect the survival of the parasitized rodents since previously infested hosts were recaptured with scars caused by the larvae leaving the host to pupate.

Linardi et al. (1991) found *A. i. intermedia* on the marsupial *Lutreolina crassicaudata* (Desmarest), and Guitton et al. (1986) found *P. r. roberti* on two species of *Nectomys*, two species of *Oryzomys*, two species of *Oxymycterus*, and on *Rattus norvegicus* (Berkenhout), *Rhipidomys mastacalis* (Lund) and *Proechimys dimidiatus* (Günther). Two acarine species, *G. oudemansi* and *H. leporispalustris*, were collected on *P. iheringi*, but they also occur on the marsupial *M. nudicaudatus* (Bossi 1996), which probably preys on *P. iheringi*.

The presence of only one *Amblyopinus* sp. was not surprising. Fonseca (1939b) collected *A. gahani* Fauvel on *N. squamipes* at Teresópolis and one of the authors (HGB) captured *N. squamipes* with *Amblyopinus* sp. in a region close to the study area. One unidentified species of *Amblyopinus* has been recovered from the marsupial *P. frenata* (Bossi 1996). Ashe and Timm (1987) suggest that the interaction between *Amblyopinus* and their hosts is probably mutualistic.

Few individuals of *N. squamipes*, a semi-aquatic rat, were captured, possibly because few traps were placed close to water. Ectoparasites were scarce on this rodent, contrasting with the findings of Linardi et al. (1987) who reported parasitism by other mites and fleas on this rodent.

The variation in rainfall between the driest and wettest months was high, but even in the dry months, the rainfall averaged approximately 100 mm/mo. The relationship between parasite intensity and period of the year was significant only for *M. apicalis* on the host *O. russatus*. The cuterebrid *M. apicalis* showed a higher incidence in the wet months as reported by Bossi and Bergallo (1992) and Vieira (1993).

According to JR Botelho (Universidade Federal de Minas Gerais, pers. comm.), *Ixodes* sp. found on the rodents, could be either *I. amarili* Fonseca or *I. loricatus* Neumann. The marsupials *D. aurita*, *M. nudicaudatus* and *P. frenata* were collected during this work and were parasitized by *I. loricatus*. This could also be the same tick species parasitizing the rodents.

The ectoparasites found on *O. russatus* showed differences in their intensities and can be separated into three groups, one formed by the mite *G. oudemansi*, and the other two by the remaining ectoparasites. *G.*

oudemansi differed from the other parasites due to its high rates of prevalence on *O. russatus*.

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REFERENCES

- Ashe JS, Timm R M 1987. Predation by and activity of "parasitic" beetles of the genus *Amblyopinus* (Coleoptera: Staphylinidae). *J Zool* 212: 429-437.
- Barros DM, Baggio D 1992. Ectoparasites Ixodida Leach, 1817 on wild mammals in the state of Paraná, Brazil. *Mem Inst Oswaldo Cruz* 87: 291-296.
- Barros DM, Linardi PM, Botelho JR 1993. Ectoparasites of some wild rodents from Paraná State, Brazil. *J Med Entomol* 30: 1068-1070.
- Barros-Battesti DM, Arzua M, Linardi PM, Botelho JR, Sbalqueiro IJ 1998. Interrelationship between ectoparasites and wild rodents from Tijuca do Sul, State of Paraná, Brazil. *Mem Inst Oswaldo Cruz* 93: 719-725.
- Bergallo HG 1994. Ecology of a small mammal community in an Atlantic Forest area in southeastern Brazil. *Studies on Neotrop Fauna and Environ* 29: 197-217.
- Bossi DEP 1996. *Ectoparasitismo em Pequenos Mamíferos da Estação Ecológica de Juréia-Itatins, Iguape (SP)*, MSc Thesis, Universidade Estadual de Campinas, Campinas, Brasil, 89 pp.
- Bossi DEP, Bergallo HG 1992. Parasitism by cuterebrid botflies (*Metacuterebra apicalis*) in *Oryzomys nitidus* (Rodentia: Cricetidae) and *Metachirus nudicaudatus* (Marsupialia: Didelphidae) in a southeastern Brazilian rain forest. *J Parasitol* 78: 142-145.
- Botelho JR, Linardi PM, Williams P, Nagem RL 1981. Alguns hospedeiros reais de ectoparasitos do município de Caratinga, Minas Gerais, Brasil. *Mem Inst Oswaldo Cruz* 76: 57-59.
- Bush AO, Lafferty KD, Lotz JM, Shostak AW 1997. Parasitology meets ecology on its own terms: Margolis et al. revisited. *J Parasitol* 83: 575-585.
- Carvalho RW, Serra-Freire NM, Linardi PM, Almeida AB, Costa JC 2001. Small rodents fleas from the bubonic plague focus located in the Serra do Órgãos mountain range, State of Rio de Janeiro, Brazil. *Mem Inst Oswaldo Cruz* 96: 603-609.
- Fonseca FOR 1939a. Espécies de *Amblyopinus* parasitas de murídeos e didelfídeos em São Paulo (Coleoptera, Staphylinidae). *Mem Inst Butantan* 12: 191-194.
- Fonseca FOR 1939b. Observação de uma fase do ciclo evolutivo de *Cuterebra apicalis* Guérin (Diptera: Oestridae). *Mem Inst Butantan* 12: 195-196.
- Gettinger D 1987. Host associations of (Acari: Laelapidae) in the Cerrado Province of central Brazil. *J Med Entomol* 24: 559-565.
- Gettinger D 1992. Host specificity of *Laelaps* (Acari: Laelapidae) in Central Brazil. *J Med Entomol* 29: 71-77.
- Guimarães LR 1945. Sobre alguns ectoparasitos de aves e mamíferos do litoral paranaense. *Arq Museu Paranaense* 4: 179-190.
- Guitton N, Araújo-Filho NA, Sherlock IA 1986. Ectoparasitos de roedores e marsupiais no ambiente silvestre de Ilha Grande, Estado do Rio de Janeiro, Brasil. *Mem Inst Oswaldo Cruz* 81: 233-234.
- Kettle DS 1985. *Medical and Veterinary Entomology*, Wiley-Interscience, New York, 658 pp.

- Kim KC 1985. *Coevolution of Parasitic Arthropods and Mammals*, Wiley-Interscience, New York, 800 pp.
- Linardi PM 1977. Relações pulgas/roedores observadas nos municípios de Salesópolis e Itapetininga, SP. *Bol Museu Hist Nat UFMG Zool* 23:1-25.
- Linardi PM 1985. Dados complementares sobre hospedeiros de sifonápteros ropalopsílinos. *Revta Bras Biol* 45: 73-78.
- Linardi PM, Guimarães LR 2000. *Sifonápteros do Brasil*, Museu de Zoologia, USP/Fapesp, São Paulo, 291 pp.
- Linardi PM, Botelho JR, Neves DP, Cunha HS 1984. Sobre alguns ectoparasitos de roedores silvestres de Belo Horizonte, MG. *Revta Bras Biol* 44: 215-219.
- Linardi PM, Botelho JR, Ximenes A, Padovani CR 1991. Notes on ectoparasites of some small mammals from Santa Catarina, Brazil. *J Med Entomol* 28: 183-185.
- Linardi PM, Teixeira VP, Botelho JR, Ribeiro LS 1987. Ectoparasitos de roedores em ambientes silvestres do município de Juiz de Fora, Minas Gerais. *Mem Inst Oswaldo Cruz* 82: 137-139.
- Monteiro-Filho ELA 1987. *Biologia Reprodutiva e Espaço Domiciliar de Didelphis albiventris em uma Área Perturbada na Região de Campinas, Estado de São Paulo*, MSc Thesis, Universidade Estadual de Campinas, Campinas, 89 pp.
- Nascimento CM, Pereira MAMG 1988. *Atlas Climatológico do Estado de São Paulo (1977-1986)*, Fundação Cargill, Campinas, 93 pp.
- Paixão ILSC 1984. *Estação Ecológica da Juréia*. Ministério do Interior, Secretaria Especial do Meio Ambiente, Brasília, 42 pp.
- SAS Institute, Inc. 1987. *S.A.S. User's Guide: Statistics*, Version 6th ed., Cary, N.C.
- Vieira EM 1993. Occurrence and prevalence of bot flies, *Metacuterebra apicalis* (Diptera: Cuterebridae), in rodents of cerrado from central Brazil. *J Parasitol* 79: 792-795.

