Siphonaptera Parasites of Wild Rodents and Marsupials Trapped in Three Mountain Ranges of the Atlantic Forest in Southeastern Brazil

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A study of the associations between small mammals and fleas was undertaken in three areas of the Atlantic Forest in Souhtheastern Brazil: Serra da Fartura, SP, Serra da Bocaina, SP, and Itatiaia, RJ. Trapping of small rodents and marsupials was done every 3 months during 2 years, from June 1999 to May 2001. A total 502 rodents (13 species) and 50 marsupials (7 species) were collected, and 185 hosts out of 552 (33.5%) captured in the traps were parasitized by 327 fleas belonging to 11 different species. New host records were determined for several flea species, and 5 significant associations between fleas and hosts were also found.

Key words: fleas - rodents - marsupials - Atlantic rain forest - Brazil

The fleas (Insecta: Siphonaptera) have approximately 3000 species worldwide with approximately 59 species and subspecies recorded from Brazil; of these, 31 were originally described from Brazilian specimens. Approximately 15% of the genera and 29% of the species are endemic. Their main hosts are mammals and they show great preference for rodents (Linardi & Guimarães 2000).

There are several studies dealing with the Brazilian flea fauna (Guimarães 1972, Botelho et al. 1981, Linardi 1985, Linardi et al. 1984, 1987, Botelho & Linardi 1996, Barros-Battesti & Arzua 1997, Barros-Battesti et al. 1998). However, few were done in areas of the Atlantic rain forest (Linardi 1977, Guitton et al. 1986, Bicho et al. 1999, Carvalho et al. 2001, Bossi et al. 2001). This ecosystem is characterized by great biodiversity and presently is under heavy pressure caused rapid urbanization and human disturbance. This study objectived to determine the flea fauna and the flea-host associations in three mountain ranges of the Atlantic forest in Southeastern Brazil: Serra da Fartura and Parque Nacional da Serra da Bocaina (state of São Paulo), and Parque Nacional do Itatiaia (state of Rio de Janeiro).

MATERIALS AND METHODS

Collections were done every three months during two consecutive years, from June 1999 to May 2001 in three areas of the Atlantic Forest in Southeastern Brazil: Serra da Fartura (São João da Boa Vista, SP - 21°53.621' W 46°45.188'), Serra da Bocaina National Park (São José do Barreiro, SP - 22°44.125' S 44°37.007' W), and Itatiaia National Park (Itatiaia, RJ - 22°26.187' S, 44°37.511' W). Small mammal trapping was conducted in an irregular grid covering 5 ha, with 14 transects varying from 200 to 240 m, spaced 20-m from each other and 1000 to 1500 m above sea level. Sherman® live traps (100) baited with banana or manioc with peanut butter were set on the forest floor for four consecutive nights. 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 cotton balls soaked with ethyl ether until they became unconscious, after which they were marked using an ear-code (Monteiro-Filho 1987), weighed, and sexed. Fleas were removed from the fur, ears, and tail with fine combs, toothbrushes or tweezers and stored in 70% alcohol. The hosts harboring specimens of *Tunga* were taken to the laboratory of the Department of Parasitology, State University of Campinas, where the fleas were removed. The hosts were subsequently released at the same trap site. A voucher collection of skins and skulls of male and female of all collected host species were kept at the Department of Ecology, State University of Rio de Janeiro. Mammal identification was based on morphological characters and cariotype, using material from the sacrificed specimens. Fleas that fell from the animals into the plastic bag during anesthesia were also stored in 70% alcohol. Each trapping was carried out for four consecutive nights, totaling eight collections in each location, and the total trapping effort was 3200 traps/night/site. Serra da Bocaina National Park belongs to the Serra do Mar mountain complex whereas the other two locations belong to the Serra da Mantiqueira complex, and the two complexes are separated by the Paraíba do Sul river valley. All three areas are covered by the Atlantic rain forest vegetation. The fleas were clarified and mounted in glass slides and identified using the key of Linardi and Guimarães (2000). The Rhopalopsyllinae were named according to the nomenclature revision proposed by Linardi and Guimarães (1993). The mean abundance, defined as *I = nr fleas/nr of collected hosts* (Bush et al. 1997), was determined for the collected species of fleas and their hosts, as well as for the three sites. This index is the same as the

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Flea Index commonly used for the Siphonapera (Linardi & Guimarães 2000).

RESULTS

A total of 502 rodents and 50 marsupials belonging to 20 species were collected. The rodents were represented by 13 species: *Akodon cursor* (Winge), *Akodon montensis* (Thomas), *Akodon serrensis* (Thomas), *Delomys dorsalis* (Henzel), *Delomys sublineatus* (Thomas), *Oligoryzomys flavescens* (Watherhouse), *Oligoryzomys nigripes* (Olfers), *Oryzomys ratticeps* (Hensel), *Oxymycterus* sp. (Watherhouse), *Thaptomys nigrita* (Lichtenstein), *Nectomys squamipes* (Brants), *Trinomys gratiosus* (Günter), and an undescribed species of *Juliomys*. The eight collected marsupial species were: *Didelphis aurita* (Wied-Neuwied), *Gracilinanus agilis* (Burmeister), *Marmosops incanus* (Lund), *Marmosops paulensis* (Tate), *Monodelphis americana* (Muller), *Monodelphis scalops* (Thomas), *Philander frenata* (Olfers), and *Thylamys velutinus* (Wagner).

The frequency of each collected species is presented in Table I. A total of 185 specimens belonging to 17 species (11 rodents and 6 marsupials) was parasitized by fleas, and *Oligoryzomys flavescens* and *Juliomys* sp. (rodents), *Marmosops paulensis*, and *Monodelphis scallops* (marsupials) had no fleas.

Considering the five most collected rodent species, the prevalence of parasitism was greater in *A. cursor* (92.3%) followed by *O. nigripes* (66.7%), *A. serrensis* (42.7%), *A. montensis* (33.3%), and *D. sublineatus* (19.6%).

The total number of collected fleas was 327, and the most abundant species was *Polygenis (Neopolygenis) pradoi* (Wagner) with 110 specimens (33.6% of the total fleas) followed by *Polygenis (Polygenis) rimatus* (Jordan) (N = 53), *Polygenis (N.) atopus* (Jordan and Rothschild) (N = 50), *Craneopsylla minerva minerva* (Rothschild) (N = 35), *Polygenis (P.) roberti roberti* (Rothschild) (N = 29), *Adoratopsylla (Adoratopsylla) antiquorum antiquorum* (Rothschild) (N = 13), *Polygenis (N.) dentei* (Guimarães) (N = 12), *Polygenis (N.) frustratus* (Johnson) (N = 8), *Tunga caecata* (Enderlein) (N = 9), *Hechtiella lakoi* (Guimarães) (N = 7), and *Polygenis (P.) tripus* (Jordan) (N = 1). The abundance for each flea species in relation to the rodent and marsupial hosts are presented respectively in Tables II and III.

Hechtiella lakoi was collected only in Itatiaia National Park, parasitizing *N. squamipes* and *T. gratiosus*, totaling respectively 50% (4 out of 8) and 100% (3 of 3) of the fleas found in these hosts. Considering the most abundant rodents, there was a strong association between *P. pradoi* and the hosts *A. montensis* and *A. serrensis*, which represented respectively 55.9% e 43.5% of the fleas collected

TABLE I

Numbers and precentages of rodents and marsupials collected between June 1999 and May 2001 at Serra da Fartura, Serra da Bocaina, and Itatiaia mountain ranges, Southeastern Brazil, and their respective flea mean abundances (I)

	Collection sites											
	Fartura			Bocaina			Itatiaia			Total		
Rodents	N	%	I	N	%	I	N	%	I	N	%[1]	I
Akodon montensis	61	29	0.46	146	70	0.57	-	-	-	207	37	0.54
A. serrensis	-	-	-	96	82	0.63	21	18	1.14	117	21	0.73
A. cursor	-	-	-	-	-	-	13	100	1.00	13	2	1.00
Delomys sublineatus	13	23	1.2	43	77	0.12	-	-	-	56	10	0.37
D. dorsalis	-	-	-	18	54	0.17	15	45	0.27	33	6	0.21
Oligoryzomys nigripes	26	86	1.38	4	13	-	-	-	-	30	5	1.20
O. flavescens	-	-	-	-	-	-	10	100	-	10	2	-
Thaptomys nigrita	12	100	0.25	-	-	-	-	-	-	12	2	0.25
Tinomys gratiosus	-	-	-	-	-	-	9	100	0.33	9	1	0.33
Oxymycterus sp.	-	-	-	-	-	-	8	100	1.37	8	1	1.37
Nectomys squamipes	1	25	1.00	-	-	-	3	75	2.33	4	1	2.00
Oryzomys ratticeps	-	-	-	1	50	1.00	1	50	3.00	2	0	2.00
Juliomys sp.	-	-	-	1	100	-	-	-	-	1	0	-
Marsupials	N	%	I	N	%	I	N	%	I	N	%[1]	I
Philander frenata	5	31	-	3	2	1.00	8	50	0.25	16	3	0.31
Marmosops incanus	-	-	-	-	-	-	8	100	1.00	8	1	1.00
M. paulensis	8	100	-	-	-	-	-	-	-	8	1	-
Gracilianus agilis	5	83	0.20	1	17	-	-	-	-	6	1	0.17
Didelphys aurita	5	100	1.00	-	-	-	-	-	-	5	1	1.00
Thyalamys velutinus	-	-	-	4	100	0.75	-	-	-	4	0	0.75
Monodelphys americana	1	50	3.00	-	-	-	1	50	-	2	0	1.5
M. scalops	-	-	-	1	100	-	-	-	-	1	0	-
Total	137	24.8	0.68	318	57.6	0.50	97	17.6	0.77	552	100	0.59

N: number of collected hosts; %: frequency of the host in each study area.; %[1]: frequency of the host considering all captured animals; I: pulicidian index (I = number of fleas/number of collected host)

TABLE II

Numbers and frequencies of fleas collected on the different rodent hosts, between June 1999 and May 2001 at Serra da Fartura, Serra da Bocaina, and Itatiaia, Southeastern Brazil

Host species	Flea species																							
	Adorapsylla antiquorum antiquorum		*Craneopsylla minerva minerva*		*Hechtiel lalakoi*		*Polygenis atopus*		*P. dentei*		*P. frustratus*		*P. pradoi*		*P. rimatus*		*P. roberti roberti*		*P. tripus*		*Tunga caecata*		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%[1]
Bocaina	3	2	25	16	-	-	11	7	7	4	1	1	79	50	33	21	-	-	-	-	-	-	159	49
Akodon montensis	1	1	10	12	-	-	8	10	-	-	-	-	50	60	14	17	-	-	-	-	-	-	83	25
A. serrensis	-	-	12	20	-	-	3	5	7	11	1	2	27	44	11	18	-	-	-	-	-	-	61	19
Delomys dorsalis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	100	-	-	-	-	-	-	3	1
D. sublineatus	-	-	1	20	-	-	-	-	-	-	-	-	-	-	4	80	-	-	-	-	-	-	5	1
Oligoryzomys ratticeps	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	100	-	-	-	-	-	-	1	0
Fartura	1	1	3	3	-	-	32	34	-	-	-	-	14	15	6	6	29	31	1	1	7	7	93	28
A. montensis	-	-	1	4	-	-	6	21	-	-	-	-	12	43	4	14	3	11	1	4	1	4	28	9
D. sublineatus	-	-	-	-	-	-	8	50	-	-	-	-	-	-	1	6	6	38	-	-	1	6	16	5
Nectomys squamipes	-	-	-	-	-	-	1	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0
O. nigripes	-	-	1	4	-	-	12	33	-	-	-	-	-	-	1	4	19	53	-	-	3	8	36	11
T. nigrita	-	-	1	33	-	-	-	-	-	-	-	-	3	67	-	-	-	-	-	-	-	-	3	1
Itatiaia	9	12	7	9	7	9	7	9	5	7	7	9	17	23	14	19	-	-	-	-	3	4	75	23
A. cursor	1	8	3	15	-	-	3	15	3	15	-	-	3	23	3	23	-	-	-	-	-	-	13	4
A. serrensis	-	-	4	17	-	-	1	4	3	12	1	4	10	42	5	21	-	-	-	-	-	-	24	7
D. dorsalis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	50	-	-	-	-	3	50	4	1
N. squamipes	-	-	-	-	4	57	-	-	-	-	-	-	-	-	3	43	-	-	-	-	-	-	7	2
O. ratticeps	-	-	-	-	-	-	3	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	1
Oxymycterus sp.	-	-	-	-	-	-	1	9	-	-	6	54	4	36	-	-	-	-	-	-	-	-	11	3
Total	13	4	35	11	7	2	50	15	12	4	8	2	110	34	53	16	29	9	1	0	9	3	327	100

N: number of fleas collected on different hosts; %: frequency of a given flea species considering all flea species on the host; %[1]: frequency of the fleas found on a given host, considering all collected fleas

TABLE III

Numbers and frequencies of fleas collected on the different marsupial hosts, between June 1999 and May 2001 at Serra da Fartura, Serra da Bocaina, and Itatiaia, Southeastern Brazil

Host species	Flea species																						Total	
	Adorapsylla antiquorum antiquorum		*Craneopsylla minerva minerva*		*Hechtiel lalakoi*		*Polygenis atopus*		*P. dentei*		*P. frustratus*		*P. pradoi*		*P. rimatus*		*P. roberti roberti*		*P. tripus*		*Tunga caecata*			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%[1]
Bocaina	3	2	25	16	-	-	11	7	7	4	1	1	79	50	33	21	-	-	-	-	-	-	159	49
Phylander frenata	2	67	1	33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	1
Thylamys velutinus	-	-	1	33	-	-	-	-	-	-	-	-	2	67	-	-	-	-	-	-	-	-	3	1
Fartura	1	1	3	3	-	-	32	34	-	-	-	-	14	15	6	6	29	31	1	1	7	7	93	28
Didelphis aurita	-	-	-	-	-	-	5	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	1
Gracilinanus agilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	100	-	-	-	-	1	0
Monodelphis americana	1	33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	67	3	1
Itatiaia	9	12	7	9	7	9.3	7	9.3	5	7	7	9	17	23	14	19	-	-	-	-	3	4	75	23
M. incanus	8	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	3
P. frenata	-	-	1	50	-	-	-	-	-	-	-	-	-	-	1	50	-	-	-	-	-	-	2	1
T. gratiosus	-	-	-	-	3	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	1
Total	13	4	35	11	7	2	50	15	12	4	8	2	110	34	53	16	29	9	1	0	9	3	327	100

N: number of fleas collected on different hosts; %: frequency of a given flea species considering all flea species on the host; %[1]: frequency of the fleas found on a given host, considering all collected fleas

on these cricetids (Table II). The association was also significant between *P. pradoi* and *A. montensis* ($\chi^2 = 8.6$; $p < 0.01$) and between *P. pradoi* and *A. serrensis* ($\chi^2 = 12.8$; $p < 0.001$), considering all three collecting sites together. A significant association between *P. pradoi* and another rodent, *Oxymycterus* sp., was found in *Araucaria* coniferous forests in souheastern of the state of Paraná (Barros-Battesti et al. 1998).

Significant associations between *P. r. roberti* and *O. nigripes* ($\chi^2 = 77$; $p < 0.001$), between *P. dentei* and *A. serrensis* ($\chi^2 = 28$; $p < 0.001$) and between *C. m. minerva* and *A. serrensis* ($\chi^2 = 8.76$ $p < 0.01$) were also found, the last one considering only associations with rodents.

Among the most abundant hosts the greatest mean abundance was found for *O. nigripes* (I = 1.38) and *D. sublineatus* (I = 1.20) in Serra da Fartura, followed by *A. serrensis* (I = 1.14) and *A. cursor* (I = 1.00) in Itatiaia, and *A. serrensis* (I = 0.63) and *A. montensis* (I = 0.57) in Serra da Bocaina (Table I). Therefore, the three areas had different mean abundances for each rodent as well as variations in the most parasitized species. In addition, Itatiaia presented a higher mean abundance (I = 0.77) (Table I). The following records of flea-host associations are new: *A. a. antiquorum* on *A. montensis* and *P. frenata*; *C. m. minerva* on *D. sublineatus*, *P. frenata* and *T. velutinus*; *H. lakoi* on *N. squamipes* and *T. gratiosus*; *P. atopus* on *A. montensis*, *A. serrensis*, and *D. sublineatus*; *P. dentei* on *A. serrensis*; *P frustratus* on *A. serrensis*; *P. pradoi* on *T. velutinus*; *P. rimatus* on *D. sublineatus* and *P. frenata*; *P. r. roberti* on *A. montensis*, *D. sublineatus*, *G. agilis*, and *Oligoryzomys* sp.; *P. tripus* on *A. montensis*; *T. caecata* in *A. montensis*, *D. dorsalis*, *D. sublineatus*, and *M. americana*.

DISCUSSION

The species *P. pradoi* was the most frequently flea with 110 specimens collected. Similar to the findings of Linardi (1985), approximately 93% of the specimens of this flea were found parasitizing rodents of the genus *Akodon*. In addition, several specimens of *P. frustratus* had morphological characteristics intermediate between this species and *P. pradoi*, fact already described by Linardi (1979), who considered this group to belong to the "*pradoi* complex". As already found by other authors (Johnson 1957, Gomes 1969, Linardi 1977, Barros et al. 1993), *P. frustratus* was always collected in the same sites as *P. pradoi*, and in many cases on the same host. Contrary to Linardi (1985), who found that *Akodon* showed a prevalence of 80% of parasitism by *P. frustratus*, in this work *A. serrensis* and *Oxymycterus* sp. presented similar infestation rates. *P. rimatus* was the flea with the widest host range, being found on eight species of rodents (Table II) and one of marsupials (Table III). However, this flea showed preference for hosts of the genus *Akodon*, since approximately 70 % of the fleas of this species were collected on this host. Linardi (1985) also found a preference of *P. rimatus* for these cricetids, but with an infestation rate of only 25%.

The species *P. r. roberti* showed a strong association with *O. nigripes*, with 52.9% of all fleas of this species being collected on this host. This result agrees with the findings of Linardi (1985). In Southeastern Brasil, *P. tripus* is more widely distributed in savannas and open areas (Linardi & Guimarães 2000). In this study this species was collected only at Serra da Fartura, an area of Atlantic Forest but close to an area of "cerrado", a savanna-like vegetation.

As reported by Linardi (1977), *P. dentei* was collected 63.6% in double or triple infestations together with *P. pradoi*, *P. rimatus*, and/or *P. atopus*, always on *Akodon* spp.

Approximately 50% of the occurrences of *P. atopus* were on *Akodon* spp., contrary to the findings of Linardi (1985), which reported a preference of this flea for *Oryzomys*. In approximately 44% of the occurrences, this species was also found in double or triple associations with *P. r. roberti*, *P. pradoi*, *P. rimatus*, *C. m. minerva*, and/or *P. dentei*.

The mean abundances found in this work were smaller than those found in Angra dos Reis, state of Rio de Janeiro (I = 3.6) (Guitton et al. 1986) and in Serra dos Órgãos National Park, Rio de Janeiro (I = 1.54) (Carvalho et al. 2001), but higher than those found in Guaraqueçaba, Paraná (I = 0.3) (Bicho et al. 1999). In addition, a new site record was determined for *T. caecata*, which is now the 24th flea species collected in the state of Rio de Janeiro.

All specimens of *Tunga* collected at Serra da Fartura were found at the base of the ears of their hosts, whereas in Itatiaia they were found at the base of the tail, a new site for *T. caecata*. All specimens of *Tunga* were determined to belong to the "*caecata* group" based on the characteristics of the neosoma (globose with invaginated head), but the identification of some distended gravid females to species was not possible.

The rodent *A. montensis* was the host with the largest number of flea species collected. It is possible that the large number of rodents collected influenced this result.

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REFERENCES

Barros-Battesti DM, Arzua M 1997. Geographical distribution by biomes of some marsupial Siphonaptera from the state of Paraná. *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 Tijucas do Sul, state of Paraná, Brazil. *Mem Inst Oswaldo Cruz 93*: 719-725.

Bicho CL, Ribeiro PB, Nascimento AP, Sbalqueiro IJ 1999. Siphonaptera de roedores silvestres em Guaraqueçaba, Paraná, Brasil. *Entomol y Vect 6*: 53-62.

Botelho JR, Linardi PM 1996. Interrelações entre ectoparasitos e roedores em ambiente silvestre e urbano de Belo Horizonte, Minas Gerais, Brasil. *Revta Bras Entomol 40*: 425-430.

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.

Bossi DEP, Linhares AX, Bergallo HG 2001. Parasitic arthropods of some wild rodents from Juréia-Itatins Ecological Station, state of São Paulo, Brazil. *Mem Inst Oswaldo Cruz 97*: 959-963.

Bush AO, Lafferty KD, Lotz JM, Shostak AW 1997. Parasitology meets ecology on its own terms: Margolis et al. revisited. *J Parasitol 83*: 575-583.

Carvalho RW, Serra-Freire NM, Linardi PM, Almeida AB, Costa JN 2001. Small rodents fleas from de bubonic plague focus located in the Serra dos Órgãos mountain range, state of Rio de Janeiro, Brazil. *Mem Inst Oswaldo Cruz 96*: 603-609.

Gettinger D 1992. Host specificity of Laelaps (Acari: Laelapidae) in Central Brazil. *J Med Entomol 29*: 71-77.

Gomes AC 1969. Pulgas colhidas em residências e sobre pequenos animais de algumas áreas do Brasil. *Revta Bras Malariol Doen Trop 21*: 775-780.

Guimarães LR 1972. Contribuição à epidemiologia da peste endêmica no Nordeste do Brasil e estado da Bahia. Estudo das pulgas encontradas nessa região. *Revta Bras Malariol Doen Trop 22*: 177-181.

Guitton N, Araújo Filho NA, Sherlock IA 1986. Ectoparasitos de roedores e marsupiais no ambiente silvestre da Ilha Grande, estado do Rio de Janeiro, Brasil. *Mem Inst Oswaldo Cruz 81*: 233-234.

Johnson PT 1957. A classification of the Siphonaptera of South America with descriptions of new species. *Mem Ent Soc Wash 5*: 1-290.

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 1979. Sobre algumas espécies de Rhopalopsyllidae (Siphonaptera) sulamericanas integrantes do "complexo *pradoi*". *Rev Bras Ent 23*: 99-106.

Linardi PM 1985. Dados complementares sobre hospedeiros de sifonápteros ropalopsilinos. *Revta Bras Biol 45*: 73-78.

Linardi PM, Guimarães LR 1993. Systematic review of genera and subgenera of Rhopalopsyllinae (Siphonaptera: Rhopalopsyllidae) by phenetic and cladistic methods. *J Med Entomol 30*: 161-170.

Linardi PM, Guimarães LR 2000. *Sifonápteros do Brasil*, Museu de Zoologia, USP/Fapesp, São Paulo, 291 pp.

Linardi PM, Botelho JR, Neves DP, Cunha HC 1984. Sobre alguns ectoparasitos de roedores silvestres de Belo Horizonte. *Rev Bras Biol 44*: 215-219.

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, State University of Campinas, Brazil.