

ECTOPARASITES OF WILD RODENTS FROM PARQUE ESTADUAL DA CANTAREIRA (PEDRA GRANDE NUCLEI), SÃO PAULO, BRAZIL

FERNANDA A. NIERI-BASTOS¹ DARCI M. BARROS-BATTESTI¹
PEDRO M. LINARDI² MARCOS AMAKU³ ARLEI MARCILI⁴ SANDRA E.
FAVORITO⁵; RICARDO PINTO-DA-ROCHA⁶

ABSTRACT:- NIERI-BASTOS, F.A.; BARROS-BATTESTI, D.M.; LINARDI, P.M.; AMAKU, M.; MARCILI, A.; FAVORITO, S.E.; PINTO-DA-ROCHA, R. **Ectoparasites of wild rodents from Parque Estadual da Cantareira (Pedra Grande Nuclei), São Paulo, Brazil.** [Ectoparasitos de roedores silvestres do Parque Estadual da Cantareira (Núcleo Pedra Grande), São Paulo, Brasil.] *Revista Brasileira de Parasitologia Veterinária*, v. 13, n. 1, p. 29-35, 2004. Laboratório de Parasitologia, Instituto Butantan, Av. Vital Brasil 1500, São Paulo, SP 05503-900, Brazil. E-mail: fernandanieri@yahoo.com.br

Sixteen ectoparasite species were collected from 195 wild rodents, between February 2000 and January 2001, in an Ecological Reserve area of the Parque Estadual da Cantareira, in the municipalities of Caieiras, Mariporã and Guarulhos, State of São Paulo, Brazil. Fifty three percent of the captured rodents were found infested, with the highest prevalences observed for the mites *Gigantolaelaps gilmorei* and *G. oudemansi* on *Oryzomys russatus*; *G. wolffsohni*, *Laelaps paulistanensis* and *Mysolaelaps parvispinosus* on *Oligoryzomys* sp. In relation to the fleas, *Polygenis (Neopolygenis) atopus* presented the highest prevalence, infesting *Oryzomys russatus*. The highest specificity indices were found for *Eubrachylaelaps rotundus/Akodon* sp.; *G. gilmorei* and *G. oudemansi/O. russatus*; and *Laelaps navasi/Juliomys pictipes*. When average infestation intensities were related to specificity indices, the relationship was only significant for *Brucepattersonius* sp. and *O. russatus* ($P < 0.05$). *Craneopsylla minerva minerva* and *Polygenis (N.) pradoi* were found for the first time on *Blarinomys breviceps*; as well as *A. fahrenheitzi*, *E. rotundus*, *G. wolffsohni*, *M. parvispinosus*, *C. minerva* and *P. atopus* on *Brucepattersonius* sp.; and *Androlaelaps fahrenheitzi*, *E. rotundus*, *G. gilmorei*, *G. oudemansi*, *Ixodes loricatus*, *L. navasi*, *L. paulistanensis*, *M. parvispinosus* and *P. atopus* on *J. pictipes*. In addition, a new locality record is presented for *L. navasi*.

KEY WORDS: Ectoparasites, mites, fleas, wild rodents.

RESUMO

Dezesseis espécies de ectoparasitos foram coletadas sobre 195 roedores, entre Fevereiro de 2000 e Janeiro de 2001, no Parque

Estadual da Cantareira, que compreende os municípios de Caieiras, Mariporã e Guarulhos, Estado de São Paulo, Brasil. Cinquenta e três por cento dos roedores capturados estavam infestados, e as maiores prevalências foram observadas para *Gigantolaelaps gilmorei* e *G. oudemansi* em *Oryzomys russatus*; *G. wolffsohni*, *Laelaps paulistanensis* e *M. parvispinosus* em *Oligoryzomys* sp. Em relação as pulgas, *Polygenis (Neopolygenis) atopus* foi a mais prevalente, infestando *O. russatus*. Os maiores índices de especificidade foram para *Eubrachylaelaps rotundus/Akodon* sp., *G. gilmorei* e *G. oudemansi/O. russatus* e *Laelaps navasi/Juliomys pictipes*. A intensidade média de infestação está relacionada ao índice de especificidade, e somente foi significante para *Brucepattersonius* sp. e *O. russatus* ($p < 0,05$). Um novo registro de localidade foi assinalado para *L. navasi*, e as seguintes espécies, *Craneopsylla minerva minerva* e *Polygenis (N.) pradoi* foram encontradas pela primeira vez em *Blarinomys*

¹Laboratório de Parasitologia, Instituto Butantan, Av. Vital Brasil 1500, 05503-900, São Paulo, SP, Brasil. E-mail: fernandanieri@yahoo.com.br

²Departamento de Parasitologia, Laboratório de Tripanosomatídeos, Instituto de Ciências Biomédicas (ICB), Universidade de São Paulo (USP), Paulo, SP, Brazil.

³Departamento de Parasitologia, Instituto de Ciências Biológicas da Universidade Federal de Minas Gerais, Belo Horizonte, MG, Brazil. CNPq Fellowship.

⁴Departamento de Medicina Veterinária Preventiva e Saúde Animal, Faculdade de Medicina Veterinária e Zootecnia, USP, São Paulo, SP, Brazil.

⁵Laboratório de Biodiversidade, Uniban, São Paulo, SP (Brazil).

⁶Departamento de Zoologia, Instituto de Biociências, USP, São Paulo, SP, Brazil.

breviceps; tanto quanto *A. fahrenheitzi*, *E. rotundus*, *G. wolffsohni*, *M. parvispinosus*, *C. minerva* e *P. atopus* em *Brucepattersonius* sp.; e *A. fahrenheitzi*, *E. rotundus*, *G. gilmorei*, *G. oudemansi*, *Ixodes loricatus*, *L. navasi*, *L. paulistanensis*, *M. parvispinosus* e *P. atopus* em *J. pictipes*.

PALAVRAS-CHAVE: Ectoparasitos, ácaros, pulgas, roedores silvestres.

INTRODUCTION

Mammals are considered preferential hosts for several species of ectoparasites and, of these, Rodentia is the most infested (WOOLEY, 1988). According to Botelho and Linardi (1996), this group can be considered one of the most important orders of mammals due to the fact that, taxonomically, it includes the largest number of species, many of which play an important epidemiological role. As reservoirs and intermediate hosts of disease causing agents on wild life, domestic animal and humans (GUIMARÃES et al., 2001).

Ectoparasites that commonly infest small wild mammals are included mostly in the Ixodida (Ixodidae and Argasidae) and Gamasida (Laelapidae and Macronyssidae) groups, in the Acari subclass and Siphonaptera (Rhopalopsyllidae) and Phthiraptera (Amblycera, Ischnocera and Hoplopleuridae) in Insecta class.

Studies dealing with rodent ectoparasites and their hosts relationship in Brazil stood out during the 80's and 90's, with several papers mainly from the state of Minas Gerais (BOTELHO et al., 1981; LINARDI, et al., 1984a; LINARDI, et al., 1984b; LINARDI, et al., 1985a; LINARDI, et al., 1985b; LINARDI et al., 1987; LOPES et al., 1989; BOTELHO; LINARDI, 1996). Other studies were also conducted in the states of Rio de Janeiro (GUITTON et al., 1986), Roraima (LINARDI et al., 1991a), Santa Catarina (LINARDI et al., 1991b) and Paraná (BARROS et al., 1993; BARROS-BATTESTI et al., 1998). Regarding to the ecology and host specificity of Laelapine mites, a recent study was conducted in the Atlantic Forest area from Ilha Grande, state of Rio de Janeiro by Martins-Hatano et al. (2002). Although several species of mites were described from the state of São Paulo by Fonseca (1935/36, 1939), there is only one recent paper, from the Estação Ecológica Juréia-Itatins (BOSSI et al., 2002), in the coast of São Paulo, that deals with the relationships among ectoparasites and rodents.

As such, the purpose of the present study was to investigate the ectoparasite fauna from wild rodents of the Parque Estadual da Cantareira, São Paulo, State of São Paulo, in an area that comprises the largest stretch of woodland in insular conditions within a metropolis.

MATERIAL AND METHODS

Study area and field procedures

The Parque Estadual da Cantareira (23°22'S and 46°36'W) constitutes a woodland reserve of 7.916.52 ha located in the northern part of the city of São Paulo, surpassing the municipality limits and including parts of Caieiras, Mairiporã

and Guarulhos. It includes five administrative nuclei (Pedra Grande, Águas Claras, Engordador, Pinheirinho and Cabuçu), of which we used Pedra Grande to conduct the present study.

Rodents were captured between February 2000 and January 2001, with 150 "live-trap" cages and 160 "pitfall-traps" during nine consecutive days each month, totalling 33.480 trapping effort. The captured rodents were anesthetized with ether and combed over a white basin. The ectoparasites were collected by brushing. After preservation in 70% ethanol, they were mounted on slides according to the conventional techniques for Acari (FLECHTMANN, 1985) and Siphonaptera (LINARDI; GUIMARÃES, 2000).

Mites were identified using the original descriptions of Fonseca (1935/36, 1939), as well as by comparison of the material with the types deposited in the Instituto Butantan Acari collection. Nomenclature follows that updated by Botelho et al. (2002). Immature tick specimens were identified based on comparison with the chaetotaxy of laboratory reared larvae material. Nomenclature and identification of fleas follow Linardi and Guimarães (2000).

Data Analysis

The prevalence of hosts infested by Acari and Siphonaptera, was expressed in percentage of the number of infested hosts out of all examined hosts.

Specificity indices were calculated for each host species that presented more than 10 captured specimens, according to Marshall (1981), using the formula:

$$SI = \frac{r_i}{\sum_i r_i} \times 100$$

where r_i is the number of parasites per individual of a given host species (represented by the index i). Note that, in the denominator, the values of r_i calculated for each host species are added up for all species, and that the multiplication by a factor 100 implies that SI will vary between 0 and 100.

A linear regression analysis was used to verify the relationship between specificity indices (SI) and infestation mean intensity (MI) in the observed hosts. A linear model was considered, given by $Y = a + bX$, where Y represents the mean intensity, X the specificity index, and a and b are, respectively, the linear and angular fitting coefficients.

In addition, the adjusted determination coefficient was estimated. This coefficient measures the "goodness of fit" of a given regression model (ZAR, 1996), and can be interpreted as an expression of the proportion of the total variability observed in Y that can be explained by or attributed to a linear dependence of Y on all observed X -values in the fitted regression model. When the angular coefficient is significantly different from 0, given the P -value < 0.05 , we can say that there is a linear relationship between X and Y (CHASE; BOWN, 1992).

Ectoparasite specimens were deposited in the Acari collection of the Instituto Butantan (IBSP) and in the Museu de Zoologia da Universidade de São Paulo (MZSP). Rodents'

Table 2. Prevalence of Siphonaptera species on wild rodents from the Parque Estadual da Cantareira, State of São Paulo, Brazil, from February 2000 to January 2001.

Siphonaptera	Hosts								Total (N=188)
	<i>Akodon</i> sp. (N=44)	<i>Blarinomys</i> <i>breviceps</i> (N=3)	<i>Brucepattersonius</i> sp. (N=11)	<i>Juliomys</i> <i>pictipes</i> (N=36)	<i>Nectomys</i> <i>squamipes</i> (N=1)	<i>Oligoryzomys</i> sp. (N=75)	<i>Oryzomys</i> <i>russatus</i> (N=17)	<i>Rhipidomys</i> <i>mastacalis</i> (N=1)	
% (IH/N) n	% (IH/N) n	% (IH/N) n	% (IH/N) n	% (IH/N) n	% (IH/N) n	% (IH/N) n	% (IH/N) n	% (IH/N) n	
<i>Craneopsylla minerva</i>	-	33.33 (1/3) 1	9.09 (1/11) 1	-	-	-	5.88 (1/17) 1	100 (1/1) 1	2.13 (4/188) 4
<i>Polygenis (Neopolygenis) atopus</i>	9.09 (4/44) 5	-	9.09 (1/11) 1	11.76 (2/17) 21	100 (1/1) 11	9.33 (7/75) 11	23.52 (4/17) 6	100 (1/1) 2	10.64 (20/188) 57
<i>P. (N.) pradoi</i>	-	33.33 (1/3) 1	-	-	-	1.33 (1/75) 1	-	-	1.07 (2/188) 2
<i>P. (P.) roberti</i>	-	-	-	-	100 (1/1) 1	-	11.76 (2/17) 2	-	1.07 (2/188) 3
Total	9.09 (4/44) 5	66.67 (2/3) 2	18.18 (2/11) 2	11.76 (2/17) 21	100 (1/1) 12	10.67 (8/75) 12	41.18 (7/17) 9	100 (1/1) 3	14.90 (28/188) 66

N. number of hosts; IH. number of infested hosts; n. number of Siphonaptera specimens.

Table 3. Average infestation intensities (MI) and values of ectoparasite specificity indices (SI) on wild rodents from the Parque Estadual da Cantareira, state of São Paulo, Brazil, from February 2000 to January 2001.

Ectoparasites	Hosts									
	<i>Akodon</i> sp.		<i>Brucepattersonius</i> sp.		<i>Oligoryzomys</i> sp.		<i>Oryzomys russatus</i>		<i>Juliomys pictipes</i>	
	M	SI	M	SI	M	SI	M	SI	M	SI
Acari										
<i>Androlaelaps fahrenheitzi</i>	2.00	15.32	1.00	4.37	3.62	30.18	2.00	11.33	3.23	38.79
<i>Eubrachylaelaps rotundus</i>	3.15	82.42	1.00	8.04	2.50	7.08	-	-	1.00	2.46
<i>Gigantolaelaps gilmorei</i>	2.00	3.77	-	-	10.00	11.08	4.00	78.22	3.00	6.93
<i>G. oudemansi</i>	1.50	0.85	-	-	4.00	1.33	20.70	91.53	18.00	6.27
<i>G. wolffsohni</i>	7.00	9.62	1.00	5.50	3.03	66.17	1.00	3.56	3.00	15.13
<i>Ixodes loricatus</i>	3.00	10.77	-	-	1.70	31.62	-	9.30	3.70	48.30
<i>Laelaps castroi</i>	-	-	-	-	1.00	100.00	-	-	-	-
<i>L. navasi</i>	1.50	2.67	-	-	5.00	5.23	13.00	29.99	6.40	62.10
<i>L. paulistanensis</i>	6.00	13.08	-	-	2.43	65.27	1.00	5.65	2.00	16.00
<i>L. thori</i>	-	-	-	-	3.00	100.00	-	-	-	-
<i>Mysolaelaps parvispinosus</i>	1.00	4.11	3.00	24.71	2.80	50.74	1.50	5.33	1.50	15.10
Siphonaptera										
<i>Craneopsylla minerva minerva</i>	-	-	1.00	-	-	-	1.00	39.29	10.50	60.71
<i>Polygenis (N.) atopus</i>	1.30	8.75	1.00	7.01	1.60	12.33	2.00	22.67	-	49.24
<i>P. (N.) pradoi</i>	-	-	-	-	1.00	100.00	-	-	-	-

following species *C. minerva* and *P. (N.) pradoi* were found for the first time on *B. breviceps*; as well as *A. fahrenheitzi*, *E. rotundus*, *G. wolffsohni*, *M. parvispinosus*, *C. minerva* and *P. atopus* on *Brucepattersonius* sp.; and *A. fahrenheitzi*, *E. rotundus*, *G. gilmorei*, *G. oudemansi*, *I. loricatus*, *L. navasi*, *L. paulistanensis*, *M. parvispinosus* and *P. atopus* on *J. pictipes*.

The average infestation intensity and specificity indices for five species of hosts are shown, for both mites and fleas, on Table 3. The relationships between the ectoparasite's specificity indices and average infestation intensities, statistically analyzed by means of linear regression considering only hosts that presented more than 10 captured individuals, are shown on Table 4.

Table 4. Values of linear regression coefficients, corresponding standard errors (SE). P-values for the tests that verify if the angular coefficient is or not different from zero, null hypotheses ($b=0$), and the adjusted coefficient of determination (R^2a).

Hosts	Coefficients					
	a	SE(a)	b	SE(b)	P-value	R ² a %
<i>Akodon</i> sp.	2.66	0.82	0.012	0.030	0.70	0.0
<i>Brucepattersonius</i> sp.	0.29	0.24	0.101	0.020	0.007	83.6
<i>Juliomys pictipes</i>	4.4	2.8	0.032	0.080	0.70	0.0
<i>Oligoryzomys</i> sp.	4.53	0.94	-0.030	0.016	0.094	16.4
<i>Oryzomys russatus</i>	0.07	2.38	0.150	0.056	0.028	40.8

a and *b* are, respectively, the linear and angular fitting coefficients.

DISCUSSION

That there is a tendency towards the decrease in the percentage of global infestation from Southern to Northern Brazil (BARROS et al., 1993), it would be expected that the infestation observed in this study was lower than that observed in the Southern region as states of Santa Catarina and Paraná, respectively, Florianópolis (100%), and Tijucas do Sul (98%), and higher than that recorded in the state of Minas Gerais for the municipalities Juiz de Fora (82,3%), Belo Horizonte (76,1%), and Caratinga (72,8%). However, the ectoparasite global infestation percentage was significantly low (53%), when compared to those of other Brazilian regions. The abundance (4.20; 833/198) was, approximately, four times lower than those cited for Mandirituba and Foz do Iguaçu and Tijucas do Sul (BARROS-BATTESTI et al., 1998), in the state of Paraná, and Juiz de Fora (LINARDI et al., 1987), Belo Horizonte, (LINARDI et al., 1984a) and Caratinga (BOTELHO, 1978), in the state of Minas Gerais.

In relation to Acari, the genus *Gigantolaelaps* is associated to the genus *Oryzomys* (GETTINGER, 1987), and this association is considered quite common (LINARDI et al., 1991b; BARROS et al., 1993; BARROS-BATTESTI et al., 1997). Nevertheless, in addition to *O. russatus*, the three collected species of *Gigantolaelaps* were also observed infesting *Oligoryzomys* sp. and *J. pictipes* rodents, and with lower prevalence on *Akodon* sp.. Two species were also observed on *N. squamipes* and one on *Brucepattersonius* sp.

Eubrachylaelaps rotundus was strongly associated to *Akodon* sp. (Table 1), in accordance to the data available in literature (MARTINS-HATANO et al., 2004). In some areas of the state of Minas Gerais, *E. rotundus* was found more frequently associated to *Bolomys lasiurus* (Lund, 1841), especially if *Akodon* was not present (LINARDI et al., 1984a). Nevertheless, in areas in which both hosts occurred, the higher prevalence was observed for the genus *Akodon* (BOTELHO et al., 1981; LOPES et al., 1989). In the present study, specimens of *E. rotundus* were also found infesting other rodent species, although with low prevalence. This was also observed in the southern (LINARDI et al., 1991b; BARROS et al., 1993; BARROS-BATTESTI et al., 1998) and southeastern regions (BOTELHO et al., 1981; LINARDI et al., 1984a; BOTELHO; LINARDI, 1988).

In relation to flea infestations, the abundance is similar to that observed in previous studies (BOTELHO; WILLIAMS, 1980; BOTELHO et al., 1981; LINARDI et al., 1984a; GUITTON et al., 1986; WHITAKER; DIETZ 1987; BOTELHO; LINARDI, 1996; BARROS-BATTESTI et al., 1998). With the exception of those rodent species that were rarely captured (less than 10 individuals), the highest prevalence of fleas was observed for *O. russatus*, even though *Akodon* sp., *J. pictipes* and *Oligoryzomys* sp. were collected in higher numbers (Table 2).

The most abundant fleas was *P. (N.) atopus*, collected on seven of eight examined hosts. The remaining species, *C. m. minerva*, *P. (P.) roberti* e *P. (N.) pradoi*, were recorded on four,

three and two hosts, respectively. Highest prevalences were obtained for *C. m. minerva* and *P. (N.) pradoi* on *B. breviceps*, *P. atopus* on *N. squamipes* and *O. russatus*, and *P. (P.) roberti* on *N. squamipes*.

Considering all collected ectoparasites with an average infestation of 10 or more parasites per host, the highest mean infestation intensities (MI) were observed for *G. gilmorei* on *Oligoryzomys* sp., *G. oudemansi* and *L. navasi* on *O. russatus*, and *G. oudemansi* and *C. minerva* on *J. pictipes*.

The highest specificity indices (SI), i.e. higher than 50%, were observed for *G. wolffsohni*, *L. castroi*, *L. thori*, *L. paulistanensis*, *M. parvispinosus* and *P. (N.) pradoi* on *Oligoryzomys* sp., followed by *G. gilmorei* and *G. oudemansi* on *O. russatus* and *L. navasi* and *C. minerva* on *J. pictipes* (Table 3). In the State of São Paulo, *L. navasi* is known from the holotype, collected on a wild rodent, probably of the genus *Oryzomys*, captured in the vicinity of the Butantan Institute in 1937 (FONSECA, 1939). A second record of this species, on *N. squamipes* and *Oryzomys lamia* Thomas, 1901, is known from Ilha Grande, state of Rio de Janeiro (GUITTON et al., 1986). In the present study, although *L. navasi* was found on *O. russatus*, *Oligoryzomys* sp. and *Akodon* sp., the highest prevalence was observed on *J. pictipes*, with high specificity index (Tables 1 and 3). The presence of *L. navasi* in the Serra da Cantareira represents not only new host records but also the second record of this species in the state of São Paulo.

As rare as *L. navasi*, *L. thori*, with only three individuals collected on *Oligoryzomys* sp. (Tables 1 and 3), represents new locality and host records, since the type, described from Brasil, has no locality or host data (FONSECA, 1939). It's occurrence was later recorded in Panamá, infesting rodents of the genera *Oryzomys* and *Peromyscus* (WENZEL; TIPTON, 1966).

In relation to the fleas, with the exception of that of *C. m. minerva* on *J. pictipes* (Table 3), the low specificity indices were expected. According to Linardi (1985), there is no host specificity among the species of the family Rhopalopsyllidae, although feeding preferences for some host taxa can be observed.

A linear relationship, at a significance level of 5%, with *P*-values < 0.05, was observed only for *Brucepattersonius* sp. and *O. russatus* (Table 4). On the other hand, less than 50% of the variability (R^2) was observed for *Akodon* sp., *Oligoryzomys* sp., *O. russatus* and *J. pictipes*, even though, according to Marshall (1981), specificity indices are directly proportional to the number of infested hosts.

Acknowledgments:-This work was partially supported by the Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) 99/05446-8 to DMBB. We thank the Instituto Brasileiro de Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA) by means of license (794/99) for permitting the capture and the handling of wild animals. We also thank Alexandre Pecquerillo for confirming the identification of wild mammals, and Donald Gettinger

for confirming the identification of *Laelaps navasi* and *L. thori*.

REFERENCES

- BARROS, D.M.; LINARDI, P.M.; BOTELHO, J.R. Ectoparasites of some wild rodents from Paraná State, Brasil. *Journal of Medical Entomology* v. 30, n. 3, p. 1068-1070, 1993.
- BARROS-BATTESTI, D.M.; ARZUA, M.; LINARDI, P.M.; BOTELHO, J.R.; SBALQUEIRO, I.J. Interrelationship between ectoparasites and wild rodents from Tijucas do Sul, State of Paraná, Brazil. *Memórias do Instituto Oswaldo Cruz* v. 93, n. 6, p. 719-725, 1998.
- BOSSI, D.E.P.; LINHARES, A. X.; BERGALLO, H.G. Parasitic arthropods of some wild rodents from Juréia-Itatins Ecological Station, State of São Paulo, Brazil. *Memórias do Instituto Oswaldo Cruz*. v. 97, n. 7, p. 959-963, 2002.
- BOTELHO, J.R., LINARDI, P.M.; WILLIAMS, P.; NAGEM, R. L. Alguns hospedeiros reais de ectoparasitos no município de Caratinga, Minas Gerais, Brasil. I. Relações pulga/hospedeiro. *Revista Brasileira de Entomologia* v. 24, n. 2, p. 27-130, 1980.
- BOTELHO, J.R.; WILLIAMS, P. Sobre alguns ectoparasitos de roedores silvestres do município de Caratinga, Minas Gerais, Brasil. II. Acarofauna. *Memórias do Instituto Oswaldo Cruz* v. 75, n. 3-4, p. 47-51, 1980.
- BOTELHO, J.R.; LINARDI, P.M. Alguns Acari Mesostigmata de roedores do município de Espinosa, Minas Gerais, Brasil. *Revista Brasileira de Entomologia* v. 32, n. 1, p. 95-97, 1988.
- BOTELHO, J.R.; LINARDI, P.M. Interrelações entre ectoparasitos e roedores em ambientes silvestre e urbano de Belo Horizonte, Minas Gerais, Brasil. *Revista Brasileira de Entomologia* v. 40, n. 3-4, p. 425-430, 1996.
- BOTELHO, J.R.; LINARDI, P.M.; MARIA, M. DE. Alguns gêneros e subgêneros de Laelapidae (Acari: Mesostigmata) associados com roedores e revalidados por meio de taxonomia numérica. *Lundiana* v. 3, n. 1, p. 51-56, 2002.
- CHASE, W.; BOWN, F. *General statistics*, 2nd ed. New York: Wiley, 1992. 645 p.
- FLETCHMANN C.H.W. *Ácaros de importância médico-veterinária*. 3 ed. São Paulo: Nobel, 1985. 192 p.
- FONSECA, F. Notas de Acarologia XX. Espécies novas de acarídeos do gênero *Laelaps*, parasitas de ratos do Brasil (Acari: Laelaptidae). *Memórias do Instituto Butantan* v. 10, p. 33-37, 1935/36.
- FONSECA, F. Novos estudos sobre o gênero *Laelaps* Koch, 1836 (Acari: Laelapidae). *Memórias do Instituto Butantan* v. 12, p. 103-123, 1939.
- GETTINGER, G. Host association of *Gigantolaelaps* (Acari: Laelapidae) in the Cerrado Province of Central Brazil. *Journal of Medical Entomology* v. 24, n. 5, p. 559-565, 1987.
- GUIMARÃES J.H.; TUCCI, E.C.; BARROS-BATTESTI, D.M. *Ectoparasitos de importância veterinária*. São Paulo: Plêiade, 2001. 213 p.
- GUITTON, N.; FILHO, N.A.A.; SHERLOCK, I. A. Ectoparasitos de roedores e marsupiais no ambiente silvestre de Ilha Grande, Estado do Rio de Janeiro, Brasil. *Memórias do Instituto Oswaldo Cruz*. v. 81, n. 2, p. 233-234, 1986.
- KREBS C.J. *Ecological methodology*. New York: Harper & Row, 1989. 654 p.
- LINARDI, P.M. Dados complementares sobre hospedeiros de sifonápteros rojalopsilinos. *Revista Brasileira de Biologia* v. 45, n. 1-2, p. 73-78, 1985.
- LINARDI, P.M.; BOTELHO, J.R.; NEVES, D.P.; CUNHA, H.C. Sobre alguns ectoparasitos de roedores silvestres de Belo Horizonte, MG. *Revista Brasileira de Biologia*. v. 44, n. 2, p. 215-219, 1984a.
- LINARDI, P.M.; BOTELHO, J.R.; CUNHA, H.C.; MOREIRA, N.S. Ectoparasitos de roedores da região urbana de Belo Horizonte, MG. I Interação entre ectoparasitos e hospedeiros. *Memórias do Instituto Oswaldo Cruz*. v. 79, n. 2, p. 239-247, 1984b.
- LINARDI, P.M.; BOTELHO, J.R.; CUNHA, H.C. Ectoparasitos de roedores da região urbana de Belo Horizonte, MG. II. Oscilações dos índices de infestação em *Rattus novergicus novergicus*. *Memórias do Instituto Oswaldo Cruz* v. 80, n. 2, p. 227-232, 1985a.
- LINARDI, P.M.; BOTELHO, J.R.; CUNHA, H.C. Ectoparasitos de roedores da região urbana de Belo Horizonte, MG. III. Índices pulcidianos, anoplurianos e acarídeos em *Rattus novergicus novergicus*. *Memórias do Instituto Oswaldo Cruz*. v. 80, n. 3, p. 277-284, 1985b.
- LINARDI, P.M.; TEIXEIRA, V.P.; BOTELHO, J.R.; RIBEIRO, L.S. Ectoparasitos de roedores em ambientes silvestres do município de Juiz de Fora, Minas Gerais. *Memórias do Instituto Oswaldo Cruz* v. 82, n. 1, p. 137-139, 1987.
- LINARDI, P.M.; BOTELHO, J.R.; RAFAEL, J.A.; VALLE, C.M.C.; CUNHA, A.; MACHADO, P.A.R. Ectoparasitos de pequenos mamíferos da Ilha de Maracá, Roraima, Brasil. I. Ectoparasitofauna, registros geográficos e de hospedeiros. *Acta Amazônica*. v. 21, p. 131-140, 1991a.
- LINARDI, P.M.; BOTELHO, J.R.; XIMENEZ, A.; PADOVANI, C.R. Notes on ectoparasites of some small mammals from Santa Catarina State, Brazil. *Journal of Medical Entomology* v. 28, n. 1, p. 184-185, 1991b.
- LINARDI, P.M.; GUIMARÃES, L.R. *Sifonápteros do Brasil*. São Paulo: Museu de Zoologia USP/FAPESP, 2000. 291 p.
- LOPES, C.M.L.; LINARDI, P.M.; BOTELHO, J.R. Ectoparasitos de roedores do município de Tiradentes, Minas Gerais. I. Ectoparasitofauna. *Memórias do Instituto Oswaldo Cruz*. v. 84, Supl. IV, p. 333-334, 1989.
- MARSHALL, A.G. *The ecology of ectoparasitic insects*. London: Academic Press, 1981. 459 p.
- MARTINS-HATANO, F.; GETTINGER, D.; BERGALLO, H.G. Ecology and host specificity of Laelapine mites (Acari:

- Laelapidae) of small mammals in an Atlantic Forest area of Brazil. *Journal of Parasitology* v. 88, n. 1, p. 36-40, 2002.
- MARTINS-HATANO, F.; GETTINGER, D.; BERGALLO, H.G. Ectoparasitas de pequenos mamíferos na Restinga de Jurubatiba. In: ROCHA, C.F.D.; ESTEVES, F.A.; SCARANO, F.R. *Pesquisas de Longa Duração na Restinga de Jurubatiba: ecologia, história natural e conservação*. São Carlos: RiMa, 2004. p. 231-241.
- WENZEL R.L.; TIPTON, V.J. *Ectoparasites of Panama*. Illinois: Field Museum of Natural History Chicago, 1966. 861 p.
- WHITAKER, J.O.; DIETZ, J.M. Ectoparasites and other associates of some mammals from Minas Gerais, Brazil. *Entomological News* v. 98, n. 4, p. 189-204, 1987.
- WOOLLEY T.A. *Acarology. Mites and Human Welfare*. Fort Collins: Library of Congress, 1988. 484 p.
- ZAR J.H. *Biostatistical analysis*. 3rd Upper Saddle River: Prentice-Hall, 1996. 918 p.

Recebido em 17 de março de 2004.

Aceito para publicação em 22 de junho de 2004.