Host-ectoparasite Specificity in a Small Mammal Community in an Area of Atlantic Rain Forest (Ilha Grande, State of Rio de Janeiro), Southeastern Brazil

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The analyses of the ectoparasite species associated with a small mammal community on Ilha Grande, a coastal island in southern of the state of Rio de Janeiro, Brazil, evaluated the level of host-ectoparasite specificity. Was used the Jaccard index for qualitative data to analyse the similarity. The lowest value of similarity occurred between Proechimys iheringi *and* Marmosops incanus *and between* Sciurus aestuans *and* Nectomys squamipes *($C_j = 0.08$) and the highest between* P. iheringi *and* Oxymycterus *sp. ($C_j = 0.33$). This index showed a low value of similarity across the ectoparasite community. The only exception from this pattern of high host specificity occurred with* P. iheringi *and* Oxymycterus *sp., which shared five species of ectoparasites. The similarity values, for most of the cases, is smaller than 0.2.*

Key words: host-parasite specificity - small mammals - parasitism - ectoparasites - Atlantic Rainforest - Rio de Janeiro - Brazil

Two strategies of host selection can be recognized in the relationship between ectoparasites and their small mammal hosts: (i) extreme specificity by the ectoparasite for a certain kind of host, and (ii) the absence of such a specificity. However, different ectoparasite species may show intermediate strategies (Timm 1983). Some ectoparasitic mites of the subfamily Laelapinae (Acari: Laelapidae) have been shown to be markedly host-specific to certain neotropical small mammal species (e.g. Furman 1972, Gettinger 1987, 1992b, Martins-Hatano et al. 2002). *Gigantolaelaps* Fonseca, 1939 and *Laelaps* Koch, 1836 occurring in association with a small mammal community in Central Brazil were completely host-specific, each ectoparasite species infesting only one particular host species (Gettinger 1987, 1992b). The author (Gettinger 1992a, b) also showed that *Laelaps* populations infesting different host species, when closely examined, were morphologically distinct, but cryptic species. Similarly, within sucking lice species (Anoplura), extreme specificity has been suggested to be the most frequent strategy (Durden & Musser 1994a). It has been suggested that ectoparasite-host interactions may be so specific that they can be used as an additional tool for the taxonomic identification of the host (Linardi 1977) and may even be indicative of common philogenetic lines (Barker 1994). However, the specificity of ectoparasites may also be related to microhabitat selection by the hosts, and as a result, when habitats are disturbed and the composition of the small mammal community changes, ectoparasites may encounter different hosts near their nest microhabitats, and transfer may occur (Gettinger & Ernest 1995). Bossi (1996) suggested that the occurrence of a particular ectoparasite species living on more than one host species may be related to the behaviour, intra and interspecific relationships, and with the microhabitats utilized by the host. The second strategy, where ectoparasite species parasitize a large number of small mammal species is common with ticks. Klompen et al. (1996) suggested that these ectoparasites usually occupy a particular habitat and as a result tend to parasite a wide range of hosts living in that particular habitat.

In many species of fleas (Order Siphonaptera) exchange among hosts is common (e.g. Linardi 1977, Botelho & Linardi 1980, 1996, Cerqueira & Linardi 1981). Linardi and Guimarães (2000), based on the study of Holland (1964), classified the hosts of fleas into four groups: primitive (those who introduce the flea species into a certain area), primary (those who are more frequently parasitized and that maintain the local infection), secondary (those that can act in the maintenance and survival of a given Siphonaptera species) and, accidental (accidents, casual occurrences or laboratory contamination).

Despite the recognized medical and veterinary importance, studies on ectoparasites and small mammals in Brazil rarely offer an ecological view of the host-ectoparasite relationship. Even so, the available studies indicate the existence of a diverse fauna of ectoparasites, and emphasize their narrow adaptation to Brazilian hosts

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(e.g. Linardi et al. 1984, 1987, 1991b, c, Guitton et al. 1986, Gettinger 1987, Gettinger & Ernest 1995, Barros-Battesti et al. 1998).

In the present study was analysed the ectoparasite species associated with a small mammal community on Ilha Grande, evaluating the level of host-ectoparasite specificity. Was adressed the following questions: (i) what ectoparasite species are associated with each small mammal host? (ii) in which extent is the occurrence of the ectoparasite relatively specific? (iii) how similar are hosts in terms of their composition of ectoparasite species?

MATERIALS AND METHODS

Study area - The study was carried out in four areas of the Atlantic rainforest surrounding the Vila Dois Rios Village (23°11'S, 44°12'W), on Ilha Grande, a coastal island in southern of the state of Rio de Janeiro, located approximately 150 km south of the city of Rio de Janeiro, in Southeastern Brazil. Ilha Grande is covered by Atlantic Rainforest with different levels of regeneration due to disturbances caused by human activities through the last centuries, but which ceased with the transformation of the area into a State Park (Araújo & Oliveira 1988). Some remnants of primary forest, where only selective cutting was carried out, can still be found in the most unaccessible central areas of the island. Annual rainfall in the area is about 2200 mm (Estação Meteorológica, Central Nuclear de Angra dos Reis - Nuclen 1996-1999) and mean annual temperature is about 23°C.

Collecting methods and analysis - Small mammals were trapped from March 1996 throughout April 1997 in one area of primary forest (Jararaca), two of secondary forests (Caxadaço and Mãe D'água) and in the anthropic area of Village Dois Rios. At each area were established grids of 70 live traps (Young and Sherman) which were set along 10 parallel transects (200 m long each one) in an area of 2 ha with each trap 20 m apart, totaling 7474 trap/nights. The traps were baited with banana and remained opened from afternoon until the next morning when they were checked for the presence of small mammals.

Each animal captured was marked (to avoid sampling the same individual) with ear-perforation code. To prevent contamination of ectoparasites between different host individuals, each individual host was anesthetized inside an individual plastic bag containing a piece of cotton soaked with sulfuric ether. The body surface of the captured small mammals was systematically checked and ectoparasites removed by combing through the pelage with the aid of a fine-tooth comb.

The ectoparasites found in each particular host were preserved in 70% ethyl alcohol, stored in host individual vials, and later identified.

To analyse the similarity of the ectoparasite community associated with different small mammal host species, was used the Jaccard index for qualitative data (Magurran 1988): $C_j = j / (a + b - j)$, in which j is the number of the ectoparasites species occuring on both species of hosts, a is the number of the ectoparasites species found on the first host species, and b is the number of the ectoparasites species found on the second host species being compared.

The convention of the ecological terms in parasitology (Bush et al. 1997) was used to calculated mean abundance (MA). To assure independence of observations in the analysis, we sampled ectoparasites from each host only once (at first capture).

RESULTS

Considering all of the sampled areas, were found ectoparasites in five rodents species [Sciuridae - *Sciurus aestuans* Thomas, 1901, n = 13; Sigmodontinae - *Oryzomys russatus* (Wagner, 1848), n = 3; *Oxymycterus* sp. Waterhouse, 1837, n = 4; *Nectomys squamipes* (Brants, 1827), n = 2 and Echimyidae - *Proechimys iheringi* Thomas, 1911, n = 35] and two marsupials species [Didelphidae - *Didelphis aurita* Wied, 1826, n = 6 and *Marmosops incanus* (Lund, 1846), n = 4]. The identification of the ectoparasite material collected from the small mammals resulted in a total of 27 identified ectoparasite taxa: Acari, Acariformes: Cheyletidae Leach, 1815 and Listrophoridae Canestrini, 1892; Acari, Parasitiformes: Macronyssidae Oudemans, 1936; *Amblyomma* sp. Koch 1844; *Ixodes* sp. Latreille, 1795; *Ixodes didelphidis* Fonseca & Aragão, 1952; *Tur* sp. Baker & Wharton, 1952; *Tur turki* Fonseca, 1959; *Gigantolaelaps goyanensis* Fonseca, 1939; *Gigantolaelaps oudemansi* Fonseca, 1939; *Laelaps manguinhosi* Fonseca, 1936; *Androlaelaps fahrenholzi* (Berlese, 1911) and *Androlaelaps marmosops* Martins-Hatano, Gettinger & Bergallo, 2001; Insecta, Amblycera: *Gliricola porcelli* (Schrank, 1781) and *Gyropus lineatus* Neumann, 1912; Insecta, Anoplura: *Polyplax spinulosa* (Burmeister, 1839); *Pterophthirus wernecki* Guimarães, 1950 and *Hoplopleura sciuricola* Ferris, 1921; Insecta, Siphonaptera: *Craneopsylla minerva minerva* (Rothschild, 1903); *Hechtiella lakoi* (Guimarães, 1948); *Polygenis (Polygenis) roberti roberti* (Rothschild, 1905); *Polygenis (Polygenis) occidentalis occidentalis* (Cunha, 1914); *Polygenis (Polygenis) rimatus* (Jordan, 1932); *Polygenis (Polygenis) tripus* (Jordan, 1933) and *Polygenis (Neopolygenis) pradoi* (Wagner, 1937) and Insecta, Coleoptera: *Amblyopinus* sp. Solsky, 1875 and *Amblyopinodes* sp. Seevers, 1955. Table I shows the ectoparasites recorded from each respective host.

Table II summarizes the similarity between different hosts species.

DISCUSSION

In most Neotropical ectoparasite studies the similarity of the host-parasite fauna is presented simply as a list or table of the shared ectoparasite species (e. g. Botelho & Williams 1980, Linardi et al. 1984, 1987, 1991a, b, 1996, Guitton et al. 1986). But in a few cases, ecological coefficients have been used to explain the associations and preferential hosts (Botelho et al. 1981, Barros-Battesti et al. 1998) or numeric analyses to cluster hosts (Lareschi 1996) and these studies have begun to clarify the level of the host-ectoparasite association (i.e. specificity/ generalization).

Our data suggests that a variety of association strategies are being utilized by ectoparasites collected at Ilha Grande. On one hand, there are the species of mites, fleas and lice which occurred with high frequency and

TABLE I

Distribution of the ectoparasites species on small mammals hosts species in the Atlantic forest area of the Ilha Grande, state of Rio de Janeiro, Brazil

	Proechimys iheringi (*n* = 35)		*Sciurus aestuans* (*n* = 13)		*Oxymycterus* sp. (*n* = 4)		*Oryzomys russatus* (*n* = 3)		*Nectomys squamipes* (*n* = 2)		*Didelphis aurita* (*n* = 6)		*Marmosops incanus* (*n* = 4)		Total (*n* = 67)	
	N	MA	N	MA	N	MA	N	MA	N	MA	N	MA	N	MA	N	MA
Acariformes																
Cheyletidae			116[a]	-											116[a]	-
Listrophoridae	77	2.2			138	34.5									215	3.5
Parasitiformes																
Macronyssidae	3	< 0.1	264	20.3	214	53.5									481	7.2
Amblyomma sp.			68	5.2											68	1.0
Ixodes sp.	23	0.7					2	0.7					1	0.3	26	0.4
Ixodes didelphidis											8	1.33			8	0.1
Tur sp.	460	13.1													460	6.7
Tur turki	650	18.6													650	9.7
Gigantolaelaps goyanensis									39	19.5					39	0.6
Gigantolaelaps oudemansi							83	27.7							83	1.2
Laelaps manguinhosi									33	16.5					33	0.5
Androlaelaps fahrenholzi	130	3.7	143	11.0	39	9.8	6	2.0	2	1.0					320	4.8
Androlaelaps marmosops													2	0.5	2	< 0.1
Amblycera																
Gliricola porcelli	17	0.5													17	0.3
Gyropus lineatus	40	1.1													40	0.6
Anoplura																
Polyplax spinulosa			49	3.8											49	0.7
Pterophthirus wernecki	453	12.9													453	6.8
Hoplopleura sciuricola			9	0.7											9	0.1
Siphonaptera																
Craneopsylla minerva minerva									1	0.5					1	< 0.1
Hechtiella lakoi	3	< 0.1													3	< 0.1
Polygenis (Polygenis) roberti roberti	3	< 0.1			1	0.3			1	0.5					5	< 0.1
Polygenis (Polygenis) occidentalis occidentalis			10	0.8											10	0.1
Polygenis (Polygenis) rimatus	1[a]	-	1	< 0.1	6	1.5									7+1[a]	0.1
Polygenis (Polygenis) tripus			1[a]	-											1[a]	-
Polygenis (Neopolygenis) pradoi					1	0.3									1	< 0.1
Coleoptera																
Amblyopinus sp.	3	< 0.1													3	< 0.1
Amblyopinodes sp.					10	2.5									10	0.1
Total	1862	53.2	544	41.9	409	102.3	91	30.3	76	38.0	8	1.3	3	0.8	2993	44.7

a: ectoparasites collected only in recaptured hosts; n: number of hosts; N: number of ectoparasites; MA: mean abundance

TABLE II

Jaccard quantitative index of similarity value among the associated ectoparasites species on different small mammals species of the Atlantic forest area of the Ilha Grande, state of Rio de Janeiro, Brazil

	Proechimys iheringi	*Sciurus aestuans*	*Oxymycterus* sp.	*Oryzomys russatus*	*Nectomys squamipes*	*Didelphis aurita*
Sciurus aestuans	0.16					
Oxymycterus sp.	0.33	0.23				
Oryzomys russatus	0.14	0.09	0.11			
Nectomys squamipes	0.12	0.08	0.20	0.14		
Didelphis aurita	-	-	-	-	-	
Marmosops incanus	0.08	-	-	0.25	-	-

were restricted to only one host species and, on the other hand, four ectoparasite taxa (Listrophoridae, Macronyssidae, *A. fahrenholzi* and *Ixodes* sp.) were also very frequent but were distributed on two, or more host species. In this cases the analyze of the MA showed a high association to one host species. The fleas *P. (P.) r. roberti* and *P. (P.) rimatus* occurred at low frequencies but also were associated with at least two host species.

The Jaccard's index showed a low value of similarity across the ectoparasite community. The only exception from this pattern of extreme host specificity occurred with *P. iheringi* and *Oxymycterus* sp., which shared five species of ectoparasites. However, the macronyssid and listrophorid mites, as well as cheyletid, could not be identified to the specific level due to the limited knowledge of the group. These taxonomic problems may have led to the production of a false cluster for macronyssid and listrophorid. In spite of these facts, the similarity values, for most of the cases, is smaller than 0.2.

The complex life cycle of ticks, in which larvae, nymphs and adult forms may parasitize individual hosts of different species (Lopes et al. 1998) may result in larvas and nymphs of *Ixodes* sp. to be largely distributed in different host species. Immature forms of ticks have already been reported to feed on more than 300 host species (Oliver Jr 1989). On the other hand, *I. didelphidis* is considered a host-specific tick. There are 29 records of this species in the Ixodides collection of Aragão deposited in the Fundação Oswaldo Cruz (all of them from the state of Goiás and of the year of 1936). This is one of the few available sources of information on this species. Of these records only three hosts are not marsupials and of the remaining 26 records, 18 are of the genus *Didelphis*.

The laelapine mites usually have specific associations with their host species. Two species of the genus *Tur* were the most frequent in the study and occurred exclusively on *P. iheringi*. The close association between *Tur* spp. and rodents of the family Echimyidae was noted by Furman (1972) and has been corroborated in several different studies (e.g. Botelho & Williams 1980, Linardi et al. 1991a). Similarly, *G. goyanensis*, *G. oudemansi* and *L. manguinhosi* were strictly host specific. Mites identified as *A. marmosops* were represented by only two individuals is the new species described by Martins-Hatano et al. (2001) from the same host species at Ilha Grande and Itatiaia (both in the state of Rio de Janeiro). The laelapine *A. fahrenholzi* had the most generalist association in the present study, occurring in all rodent host species captured. Barros-Battesti et al. (1998) reported a similar association, with six of eight species of mammalian hosts studied parasitized with *A. fahrenholzi*. Similar associations have been observed in another studies (e.g. Botelho & Linardi 1996, Lareschi 1996). Furman (1972) noted that *A. fahrenholzi* may not be a single species, but a complex of species. Despite of the marked specificity found in our data, other studies have shown that laelapine mites often share different host species (e.g. Botelho & Williams 1980, Botelho et al. 1981, Linardi et al. 1984, Guitton et al. 1986). Furman (1972) reported that laelapine mites were often associated with hosts at a higher taxonomic level (genus, family).

Many fleas utilize an intermediate strategy between total specificity and generalization. In Brazil, several studies describe different host species being shared by a particular flea species (e.g. Linardi et al. 1984, 1991a, c, Guitton et al. 1986, Botelho & Linardi 1996, Carvalho et al. 2001) and others provide calculations of the "true host" (Botelho et al. 1981, Barros-Battesti et al. 1998). Because fleas are important vectors of plague, exchange of fleas between wild and domestic rodent hosts can be important in the maintenance of epizootics and zoonoses (Carvalho et al. 2001).

Were collected five species of monoxenic, and two of polyxenous fleas. *Polygenis (P.) r. roberti* had the widest distribution among the flea species in this study. From data on host-parasite relationships obtained in the available literature, Linardi and Guimarães (2000) mention the genus *Oryzomys* as the main host (46% of the cases) of *P. (P.) r. roberti*. Because in our study only three specimens of *O. russatus* are collected, none of this flea was found in this host. Also, Guitton et al. (1986), working on Ilha Grande, reported *P. (P.) r. roberti* predominantly from hosts of the genus *Oryzomys* (54.4%). Another flea species which is known to occur on more than one host species is *P. (P.) rimatus*. Linardi and Guimarães (2000) point out as the main hosts for this flea are rodents of the genera *Akodon* and *Oryzomys*. Since species of *Akodon* were not found in Ilha Grande and few specimens of *O. russatus* were collected, in the present study, *P. (P.) rimatus* occurred on *P. iheringi*, *S. aestuans* and *Oxymycterus* sp. However, only one specimen was collected from a recaptured individual of *P. iheringi*, where as on individuals of the genus *Oxymycterus,* this flea species represented the largest relative density of all the siphonapterans.

Within fleas the monoxenic cycle *P. (P.) o. occidentalis* is considered as rare, representing less than a percent of the collections (Linardi & Guimarães 2000). Even so, those authors describe the presence of this flea in mammals (Rodentia, Marsupialia, Carnivora and Edentata), and birds. In the present study this flea species was the most frequent and specific. *Hechtiella lakoi* is restricted to the Atlantic Forest Biome, having as main host *P. iheringi* (Linardi & Guimarães 2000), which also occurred in our study. *P. (P.) tripus* was widely distributed among host species, as well as in geographical regions (Linardi & Guimarães 2000). In our study, only one individual of that species was collected from a recaptured individual of *S. aestuans*.

References on the specific relationships between ectoparasites and host species are frequent for the lice of the suborders Amblycera (Emerson & Price 1981) and Anoplura (Johnson 1972, Durden & Musser 1994a, b). However, this relationship is still poorly known in Brazil. The sucking louse *H. sciuricola* is considered as a species with a low degree of specificity, parasitizing different species of the family Sciuridae, mainly of the genus *Sciurus* (Johnson 1972, Durden & Musser 1994a). In this study *H. sciuricola* was collected exclusively on *S. aestuans*. Durden and Musser (1994a, b) list *P. iheringi* as the specific host of *P. wernecki*, being this pattern also now observed. *Polyplax spinulosa*, which in our study was restricted to *S. aestuans*, is indicated as a parasite of cosmopolitan distribution (Durden & Musser 1994b), occurring mainly on species of the genus *Rattus*. In Brazil, it is associated primarily with *R. norvegicus* (e.g. Linardi et al. 1987, Botelho & Linardi 1996), *R. rattus* and *A. cursor* (Oliveira et al. 2001).

P. iheringi was the only host of chewing lice in this study. Guitton et al. (1986) present three species collected on *Proechimys* [*Gyropus lineatus*, *Gliricola porcelli,* and *Trimenopon jenningsi* (Kellogg & Paine, 1916)] and *Cavia* [*Gyropus ovalis* Burmeister, 1838, *G. porcelli,* and *T. jenningsi*]. The shared species present a considerable difference in the distribution: *G. porcelli* on *Proechimys* (83.3%) and *T. jenningsi* on *Cavia* (96%).

The beetles *Amblyopinus* sp. and *Amblyopinodes* sp. now are recognized as mutualists and non-parasites (Ashe & Timm 1987). The species of that group are primarily associated with South American cricetid and caviomorph rodents, and marsupials, and there is consistent evidence of host specificity (Ashe & Timm 1995). The occurrence of these two beetle species associated to rodent species of distinct taxonomic groups seems to affirm that fact.

We conclude that the species of the ectoparasite community associated with small mammals on Ilha Grande are relatively specific, resulting in a composition of ectoparasite species particular to each host species.

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