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Helminths of lizards from the municipality of Aripuanã in the southern Amazon region of Brazil

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Abstract

Ninety-five specimens from 13 species of lizard collected during a herpetofaunal monitoring programme of the Faxinal II power plant, municipality of Aripuanã, state of Mato Grosso, Brazil (southern Amazon region) were examined for helminths. A total of 21 helminth species (16 Nematoda, 1 Cestoda and 4 Trematoda) were recovered, with an overall prevalence of 67.37%. Seventeen new host records and seven new locality records are reported. A low number of specialists and core helminth species were found. Lizard body size was positively correlated with both the total number of helminth species and individuals. Active foragers exhibited higher helminth diversity. However, sit-and-wait foragers, especially *Plica plica*, had similar diversity values as active foragers and harboured more helminth species. The degree of similarity in helminth fauna was higher among closely related host species.

Introduction

The Brazilian Amazon harbours more than 100 species of lizard (Ávila-Pires, 1995). Despite this diversity, studies on helminths of Amazonian lizards are scarce and basically consist of species descriptions (see Freitas & Lent, 1938; Alho, 1965; Bain, 1974). However, there has been a recent increase in taxonomic studies and many species, such as *Allopharynx daileyi* from *Uranoscodon superciliosus* (Bursey *et al.*, 2005a) and *Cosmocerca vrcibradici* from *Cercosaura eigenmanni* and *C. oshaughnessyi* (Bursey & Goldberg, 2004) have been described.

There has also been an increase in ecological studies on parasitism and many lizard species have been studied, such as *Anolis fuscoauratus* (Goldberg *et al.*, 2006a), *Anolis punctatus, A. transversalis* (Goldberg *et al.*, 2006b), *Alopoglossus angulatus, A. atriventris* (Goldberg *et al.*, 2007a), *Kentropyx calcarata*, *Leposoma osvaldoi* and *Potamites ecpleopus* (Goldberg *et al.*, 2007b). However, the studies cited are restricted to the northern portion of Brazilian Amazon and no investigations have been carried out in the southern Amazon.

The aim of the present study was to analyse the helminth fauna of a lizard community in the municipality of Aripuanã, state of Mato Grosso, Brazil (southern Amazon region).

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Materials and methods

Collection and examination of lizards

Ninety-five lizards were collected during the herpetofaunal monitoring programme of the Faxinal II hydroelectric power plant (10°9′0″S, 59°27′0″W) in the municipality of Aripuanã (Mato Grosso, Brazil). Captures were carried out using pitfall traps with drift fences and by hand from September 2006 to July 2008. The lizards were euthanized, fixed in a 10% formalin solution and preserved in 70% ethanol. Voucher specimens were deposited in the Zoological Collection of the Universidade Federal de Mato Grosso (Brazil).

In the laboratory, a longitudinal incision was made from the throat to the vent of each lizard specimen and the body cavity, lungs, biliary vesicle and gastrointestinal tract were examined using a dissecting microscope. Helminths were placed in vials with 70% ethanol for subsequent identification. Nematodes were cleared in phenol and trematodes and cestodes were stained in carmine and cleared with creosote. Species identification was performed with the aid of a computerized image analysis system (Qwin Lite 3.1, Leica Microsystems,

Table 1. Epidemiological data on lizards and respective parasites in the municipality of Aripuanã, Mato Grosso, Brazil. For each host species, the number of specimens examined (*N*), mean snout–vent length (SVL), prevalence (P), intensity of infection (I, mean ± SD) and infection sites of each nematode are given.

Host	*N*	SVL	Parasite	P	I	Site
Iguanidae						
Iguana iguana	7	154.7 ± 104.8	*Alaeuris vogelsangi*	14.3	34 400	LI
			Cosmocercidae larvae	14.3	1	L
			Helicotrema magniovatum[b]	28.6	11 ± 8.5	SI
			Ozolaimus cirratus[b]	14.3	12 241	SI, LI
			Ozolaimus megatyphlon		6585 ± 7786.7	LI
Hoplocercidae						
Hoplocercus spinosus	3	89.8 ± 8.6	*Africana dardanelosi*	100	7 ± 8.7	
Polychrotidae						
Anolis fuscoauratus	4	42.9 ± 3.3	*Mesocoelium monas*[a, b]	25	8	SI
			Oswaldocruzia vitti	25	4	LI
			Physaloptera retusa	50	3 ± 1.4	S
			Skrjabinellazia galliardi[a, b]	25	2	LI
			Strongyluris oscari	50	1	LI
Anolis ortonii	1	42.7	Not parasitized	–	–	–
Anolis phyllorhinus	1	82.3	*Oswaldofilaria* sp.[a]	100	1	BC
Tropiduridae						
Plica plica	13	105 ± 29.4	*Mesocoelium monas*[a]	15.4	6.5 ± 7.8	SI
			Paradistomum parvissimum[a]	7.7	1	BV
			Parapharyngodon sceleratus[a]	23.1	2.7 ± 1.5	LI
			Piratuba sp.[a]	7.7	1	LI
			Physaloptera lutzi[a]	7.7	70	S
			Physaloptera retusa	84.6	36.7 ± 38.9	S, SI
			Strongyluris oscari	69.2	18.8 ± 19.1	SI, LI
Uranoscodon superciliosus	10	101.2 ± 31.6	*Allopharynx daileyi*[b]	40	6.5 ± 6.4	SI
			Mesocoelium monas	10	2	SI
			Paradistomum parvissimum[a]	10	18	BV
			Parapharyngodon sceleratus[a]	10	1	LI
			Strongyluris oscari[a]	20	3 ± 1.4	LI
Gekkonidae						
Hemidactylus mabouia	6	56.5 ± 11.3	*Parapharyngodon sceleratus*	16.7	6	LI
Phyllodactylidae						
Thecadactylus solimoensis	3	115.5 ± 26.7	*Mesocoelium monas*[a]	33.3	8	SI
			Parapharyngodon sceleratus[a]	33.3	11	SI, LI
Sphaerodactylidae						
Coleodactylus amazonicus	4	21.9 ± 0.6	*Physaloptera retusa*[a]	75	3 ± 1.7	S
Gonatodes hasemani	3	33.1 ± 4.2	Not infected	–	–	–
Gonatodes humeralis	8	34.4 ± 3.4	*Parapharyngodon sceleratus*[a]	37.5	1.3 ± 0.6	LI
			Physaloptera retusa[a]	25	10 ± 12.7	S
Teiidae						
Ameiva ameiva	12	113.4 ± 23.2	*Oochoristica ameivae*[b]	41.67	9.2 ± 10.8	SI
			Parapharyngodon sceleratus	25	1	LI
			Physaloptera retusa	75	7.2 ± 11.9	S
			Physalopteroides venancioi	8.3	1	S
			Spinicauda spinicauda	83.3	14.9 ± 32.5	LI, SI
Kentropyx calcarata	10	79.3 ± 16.5	*Kentropyxia sauria*[b]	30	11 ± 14.1	SI
			Oochoristica ameivae[a]	20	1	SI
			Paradistomum parvissimum[a]	10	25	BV
			Physaloptera retusa	60	3.7 ± 4.4	S
Gymnophthalmidae						
Cercosaura eigenmanni	2	41.1 ± 0.5	Not parasitized	–	–	–
Leposoma osvaldoi	8	29.7 ± 4.5	*Cosmocerca* sp.	12.5	6	LI
			Oswaldocruzia vitti[a]	25	2.5 ± 2.1	SI

Abbreviations for infection sites: BC, body cavity; S, stomach; LI, large intestine; SI, small intestine; L, lungs.
[a] New host record.
[b] New state record.

Wetzlar, Germany). Voucher specimens are deposited in the Helminth Collection of the Instituto de Biociências of the Universidade Estadual Paulista, Botucatu Campus, city of Botucatu, state of São Paulo, Brazil.

Data analysis

The ecological terms used throughout this text follow Bush *et al.* (1997). The diversity of the nematode fauna associated with each host species was estimated using Brillouin's diversity index (Magurran, 1988), considering only parasitized individuals. The classification of helminths followed Roca (1993): prevalence values greater than 30% were considered indicative of core species and values between 10 and 30% were considered indicative of secondary species. The helminth classification as generalist (not restricted to a single host species) or specialist (in single host species) followed Bursey *et al.* (2005b). The classification of lizard foraging mode followed Vitt (1991), Vitt & Zani (1998) and Vitt *et al.* (2003). The effect of lizard body size was tested by calculating Pearson's correlation coefficients between lizard snout–vent length (SVL) and both the total number of parasites and number of helminth species for each lizard host. The Jaccard index was used for the determination of between-species similarities in the composition of the nematode community using qualitative data only, thereby avoiding comparisons between specimens collected in different areas and seasons. To evaluate the similarity between species, the qualitative data were subjected to unweighted pair group method with arithmetic mean (UPGMA) cluster analysis using Sorensen's coefficient of the Multi-Variate Statistical Package (MVSP version 3.1) (Kovach, 2007).

Results

A total of 74,167 helminths belonging to 21 species were recovered (16 nematodes, 1 cestode and 4 trematodes). The overall prevalence was 67.37%. The nematodes *Physaloptera retusa* and *Parapharyngodon sceleratus*, from the stomach and large intestine, respectively, were found infecting more lizard species (6 each), followed by the trematode *Mesocoelium monas*, which infected four lizard species (table 1). Among the 41 records, few helminths (36.6%) were considered core species and the majority were considered secondary species. *Physaloptera retusa* attained the status of core species in more lizard species (table 1).

Two (2.1%) individual lizards with a sit-and-wait foraging mode harboured the most helminth species (4): one *Iguana iguana* and one *Plica plica*. Eleven (11.6%) individual lizards harboured three helminth species (active foragers: six *Ameiva ameiva* and two *Kentropyx calcarata*; sit-and-wait foragers: two *P. plica* and one *Anolis fuscoauratus*). Another 20% harboured two helminth species and 33.7% were infected by only one helminth species.

The highest diversity was found in the teiid *A. ameiva* (0.46 ± 0.32), followed by the tropidurid *P. plica* (0.36 ± 0.28) and the polychrotid *A. fuscoauratus* (0.27 ± 0.36) (table 2). However, *P. plica* was found to harbour more helminth species (7) (table 1).

Table 2. Similarity (Jaccard index) and Brillouin diversity index (bold type in diagonal) of helminths for lizards in the municipality of Aripuanã, Mato Grosso, Brazil. Kc, *Kentropyx calcarata*; Aa, *Ameiva ameiva*; Af, *Anolis fuscoauratus*; Ap, *Anolis phyllorhinus*; Ca, *Coleodactylus amazonicus*; Gh, *Gonatodes humeralis*; Hm, *Hemidactylus mabouia*; Hs, *Hoplocercus spinosus*; Ii, *Iguana iguana*; Lo, *Leposoma osvaldoi*; Pp, *Plica plica*; Ts, *Thecadactylus solimoensis*; Us, *Uranoscodon superciliosus*.

	Kc	Aa	Af	Ap	Ca	Gh	Hm	Hs	Ii	Lo	Pp	Ts	Us
Kc	**0.15 ± 0.38**												
Aa	0.29	**0.46 ± 0.32**											
Af	0.13	0.11	**0.27 ± 0.36**										
Ap	0	0	0	**0**									
Ca	0.25	0.20	0.20	0	**0**								
Gh	0.20	0.40	0.17	0	0.50	**0**							
Hm	0	0.20	0	0	0	0.50	**0**						
Hs	0	0	0	0	0	0	0	**0**					
Ii	0	0	0	0	0	0	0	0	**0.13 ± 0.29**				
Lo	0	0	0.17	0	0	0	0	0	0	**0**			
Pp	0.22	0.20	0.33	0	0.14	0.29	0.14	0	0	0	**0.36 ± 0.28**		
Ts	0	0.17	0.17	0	0	0.33	0.50	0	0	0	0.29	**0.20 ± 0.34**	
Us	0.13	0.11	0.25	0	0	0.17	0.20	0	0	0	0.50	0.40	**0.07 ± 0.15**

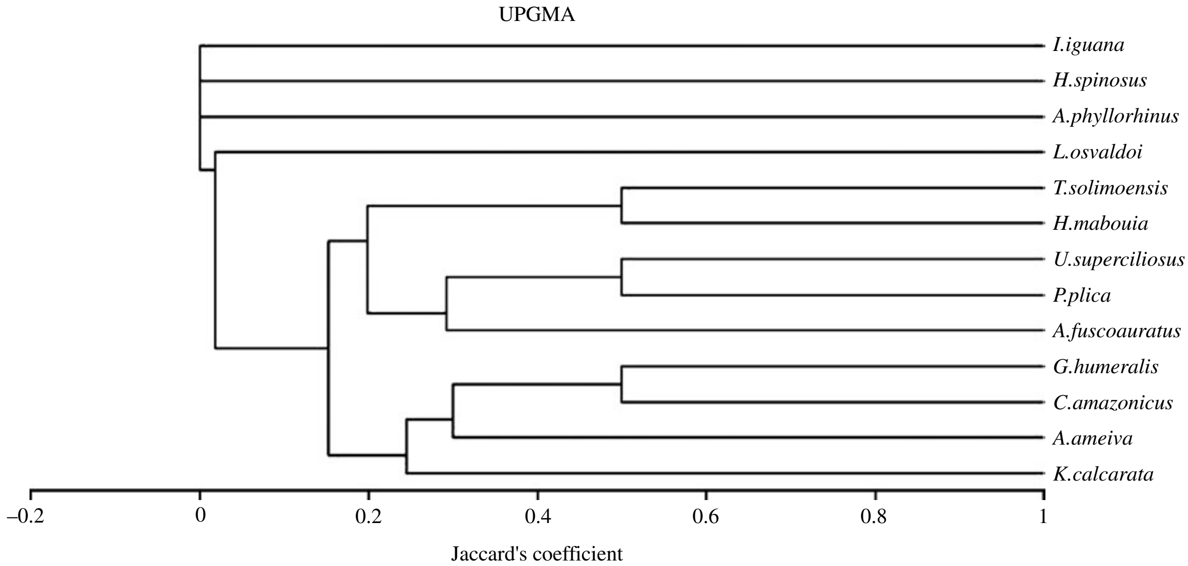

Fig. 1. UPGMA cluster analysis of helminth communities of lizards from the municipality of Aripuanã in the southern Amazon region of Brazil.

Both the total number of helminth species ($R = 0.53$, $P < 0.001$) and total number of parasites ($R = 0.66$, $P < 0.001$) were correlated with lizard SVL. Similarities in helminth fauna were greater between phylogenetically closer lizard species, such as two pairs of gekkotans (*Thecadactylus solimoensis*–*Hemidactylus mabouia* and *Gonatodes humeralis*–*Coleodactylus amazonicus*) and the tropidurids *P. plica* and *Uranoscodon superciliosus* (fig. 1). Three species (*I. iguana*, *Hoplocercus spinosus* and *Anolis phyllorhynus*) had no similarity in helminth fauna with any other lizard species.

Discussion

Despite the small sample size for many lizard species, 17 new host records and seven new locality records are reported in the present paper, which can be considered a substantial contribution for the Amazon region. According to Aho (1990), the helminth fauna of reptiles is depauperate in comparison to other vertebrates and is dominated by generalist species. This statement is corroborated by a number of studies carried out in the Neotropical region (e.g. Vrcibradic *et al.*, 2000; Bursey *et al.*, 2005c) as well as the present investigation.

Interesting patterns of helminth richness were observed between lizards with different foraging modes. The highest diversity was found in the active forager *A. ameiva*, followed by the sit-and-wait forager *P. plica*. However, when the total numbers of helminth species per individual and per lizard species were analysed, sit-and-wait foragers tended to harbour more helminths than active foragers. Although Aho (1990) suggests that active foragers tend to harbour a richer and more complex helminth fauna, a number of studies on Brazilian lizards reveal the opposite trend, with tropidurids exhibiting the richest fauna (see Ribas *et al.*, 1998; Vrcibradic *et al.*, 2000). A diversified diet, with higher values of niche breadth, including plant material, and higher percentages of ants may be responsible for this pattern, as found in many tropidurid species (Vrcibradic *et al.*, 2000). Like populations of *Tropidurus*, lizards of the genus *Plica* have a diversified diet, involving a greater proportion of ants (Vitt, 1993).

Lizard body size exerts an effect on the diversity and abundance of helminths. This association has been tested in many lizard species (Fontes *et al.*, 2003; Rocha *et al.*, 2003; Anjos *et al.*, 2005). According to Kuris *et al.* (1980), this relationship is compatible with MacArthur and Wilson's Island Biogeography Theory: hosts may act as islands. Besides providing a larger niche, body size has a substantial impact on other ecological features of lizards, such as diet and habitat use (see Pianka & Vitt, 2003), thereby influencing the associated helminth fauna.

Similarities in helminth fauna tend to be greater between closely related sympatric lizards (see Aho, 1990; Vrcibradic *et al.*, 2000). Phylogeny has a substantial impact on lizard ecology (Pianka & Vitt, 2003), which is reflected in the establishment of the helminth community (Poulin, 1997). This may explain the similarities found in the present study and may partially be related to the substantial differences found in *I. iguana* and *H. spinosus*, but do not explain the distinction of *A. phyllorhynus* regarding its helminth fauna. In the latter species, the small sample size may account for the lower degree of similarity and the most depauperate helminth fauna among all the lizard species analysed.

In conclusion, the patterns found in the present study are in agreement with those found in reptiles, i.e. depauperate fauna characterized by many generalist species and greater similarity, likely due to host phylogeny.

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