

Helminth fauna of *Leptodactylus syphax* (Anura: Leptodactylidae) from Caatinga biome, northeastern Brazil

Helmintofauna de *Leptodactylus syphax* (Anura: Leptodactylidae) do bioma da Caatinga, Nordeste do Brasil

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Received November 30, 2016

Accepted February 21, 2017

Abstract

Leptodactylus syphax is distributed in central, southeastern and northeastern Brazil, eastern Bolivia and southern Paraguay, occupying open areas and rock outcrops, in rock cavities and termite burrows. We collected 21 frogs from the Caatinga region of the state of Ceará, northeastern Brazil, and 7,021 helminths were recovered from 18 of these hosts (overall prevalence = 85.7%). Six helminth taxa were recovered, as follows: *Aplectana membranosa* (n = 3,756); *Schrankiana formosula* (n = 3,176); larvae of *Physaloptera* sp. (n = 43); unidentified nematode larvae (n = 7); digenean metacercariae of *Lophosicyadiplostomum* sp. (n = 2); and cystacanths of *Acanthocephala* (n = 37). The similarity of helminth composition between *L. syphax* from the Caatinga and other species of the *L. fuscus* group showed that some anurans were clustered according to parasite species and others according to geographic locality. This study presents new helminth records for the Neotropical region, thus helping in understanding the pattern of species distribution, and it increases the knowledge of parasites associated with amphibians.

Keywords: *Leptodactylus fuscus* group, helminths, parasites, *L. syphax*, Caatinga.

Resumo

Leptodactylus syphax está distribuída na região central, Sudeste e Nordeste do Brasil, Leste da Bolívia e Sul do Paraguai, ocupando áreas abertas e afloramentos rochosos, cavidades rochosas ou de cupins. Foram coletadas 21 rãs oriundas da região de Caatinga do Ceará, nordeste brasileiro, e 7.021 helmintos foram recuperados em 18 hospedeiros (prevalência geral = 85,7%). Seis taxa de helmintos foram recuperados, como segue: *Aplectana membranosa* (n = 3.756), *Schrankiana formosula* (n = 3.176), larvas de *Physaloptera* sp. (n = 43), larvas de nematódeos não identificado (n = 7), metacercárias de *Lophosicyadiplostomum* sp. (n = 2), e cistacantos de Acanocéfalos (n = 37). A similaridade da composição de helmintos entre *L. syphax* da Caatinga e outras espécies do grupo *L. fuscus* mostrou que alguns anuros foram agrupados de acordo com a espécie do parasita e outros de acordo com a localidade geográfica. Este estudo apresenta novos registros de helmintos para a região Neotropical, ajudando na compreensão do padrão de distribuição das espécies e aumenta o conhecimento sobre os parasitas associados a anfíbios.

Palavras-chave: *Leptodactylus fuscus* grupo, helmintos, parasitas, *L. syphax*, Caatinga.

Introduction

Knowledge about biological diversity and its distribution is of such importance that it should be considered before any further study. Global diversity includes parasites such as helminths, which

are associated with several vertebrates and can be modulated by their host and environment. Helminths can also influence host population conditions through co-evolutionary processes (POULIN, 1995, 1999). Compared with what is known about the helminth fauna of some vertebrates, such as fish, birds and mammals, knowledge of helminth richness in amphibians is relatively poor (AHO, 1990). Considering the richness of anuran species in Brazil – around 1026 species (SEGALLA et al., 2014; FROST,

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2015) – the number of helminth species is expected to be higher. In the Caatinga biome, located in northeastern Brazil, there are approximately 53 anuran species, and most of them have an unknown helminth fauna (ALBUQUERQUE et al., 2012; CAMPIÃO et al., 2014). One of these species is *Leptodactylus syphax* (Bokermann, 1969), which is distributed across central, southeastern and northeastern Brazil, eastern Bolivia and southern Paraguay, occupying open areas and rocky outcrops, in rock or termite cavities. This species does not seem to adapt well to anthropogenic disturbance (IUCN, 2015).

According to De Sá et al. (2014), the leptodactylid species *Leptodactylus syphax* was placed in the *Leptodactylus fuscus* group, which is composed of species of similar sizes that occupy similar niches and are phylogenetically close together. On the other hand, the species of this group have wide distribution and occupy different habitats, which can influence component communities of related parasites (GOATER & GOATER, 2001). However, there is only one record of a helminth parasite associated with *L. syphax*: the nematode *Aplectana* sp., which was reported from the state of Mato Grosso do Sul, Brazil (CAMPIÃO et al., 2014).

In the present study, the component community of helminths associated with *L. syphax* in the Caatinga, Brazil, is reported. In addition, the similarity of helminth community composition in other species of the *L. fuscus* group from different South American regions is compared in order to analyze whether clusters were formed according to geographic region or helminth species.

Materials and Methods

This study was conducted in the municipality of Farias Brito, Cariri region, state of Ceará, northeastern Brazil. Twenty-one specimens of *L. syphax* were collected through visual encounter surveys from February 2013 to August 2014, fixed in 10% formalin, preserved in 70% alcohol and then deposited in the Herpetological Collection of the Regional University of Cariri, (URCA-H 4864, 4865, 4866, 4867, 4868, 4876, 4882, 4923, 4924, 4925, 4926, 4929, 4933, 4936, 4938, 7144, 7145, 7149, 7152, 9823, 9949), municipality of Crato, state of Ceará. All organs were removed and examined individually under a stereoscope

and the helminths collected were transferred to 70% ethanol. Larvae of Acanthocephala (cystacanths) and metacercariae were stained with alcoholic hydrochloric acid-carmin and cleared in creosote, while nematodes were diaphanized in lactophenol. Helminths were deposited in the Coleção Helmintológica do Instituto de Biociências de Botucatu (CHIBB 7956, 7957, 7958, 7959, 7960, 7961, 7962, 7963, 7964, 7965, 7966, 7967, 7968, 7969, 7970, 7971, 7972, 7973, 7974, 7975, 7976, 7977, 7978). Subsequently, these temporary slides were analyzed using a microscope equipped with the LASV3.8 image system. The collection of specimens of *L. syphax* was authorized by SISBIO (#32758-2).

As described by Bush et al. (1997), we used ecological descriptors such as prevalence, mean abundance and mean intensity of infection. These descriptors were calculated in the SigmaStat 3.1 software (SYSTAT Software, Inc.). The similarity of the helminth fauna of the *L. fuscus* species group in which *L. syphax* is included was analyzed considering the geographic localities occupied by these species, and a cluster analysis was performed using the Bray-Curtis similarity index performed using the Past software (BRAY & CURTIS, 1957), scored as presence (1) or absence (0) of data on helminth species.

Results

Helminths associated with Leptodactylus syphax from the Caatinga

We recovered 7,021 helminths from 18 of the 21 specimens of *L. syphax*, thus resulting in overall prevalence of 85.7%, mean abundance of 334.3 ± 85.0 and an average of 390.0 ± 93.0 helminths in each infected host, with parasitism intensity ranging from at least two up to 1,300 helminths. The mean richness was 1.4 ± 0.2 species and the taxon richness in the component community comprised four nematode species: *Aplectana membranosa* (n = 3756); *Schrankiana formosula* (n = 3176); larvae of *Physaloptera* sp. (n = 43); unidentified larvae (n = 7); digenean metacercariae of *Lophosicyadiplostomum* sp. (n = 2); and cystacanths of Acanthocephala (n = 37) (Table 1).

Table 1. Prevalence (P%), mean intensity of infection (MII), mean abundance (MA) with standard error (SE), range of infection (Ri) and site of infection (SI) of helminths associated with *Leptodactylus syphax* from the Caatinga, Brazil.

Helminthes	P%	MI	Ri	MA	SI*
Nematoda					
<i>Aplectana membranosa</i>	71.4	250.4 \pm 63.0	2-771	178.8 \pm 51.2	Si, Li
<i>Schrankiana formosula</i>	42.9	353.0 \pm 128.1	6-1000	151.2 \pm 65.9	Li
<i>Physaloptera</i> sp. (larvae)	9.5	21.5 \pm 19.5	2-41	2.0 \pm 1.9	Sto
Unidentified larvae	4.8	7.0	-	0.3 \pm 0.3	Cav
Digenea					
<i>Lophosicyadiplostomum</i> sp. (metacercariae)	4.8	2.0	2	0.1 \pm 0.1	Kid
Acanthocephala					
Cystacanths	4.7	37.0	37	1.7 \pm 1.7	Cav
Total	85.7	390.0 \pm 93.0	2-1300	334.3 \pm 85.0	-

*Si (small intestine), Li (large intestine), Sto (stomach), Cav (body cavity), and Kid (kidneys).

Figure 1. Cluster analysis based on the composition of helminth parasites of the *Leptodactylus fuscus* group from South America. Host species: *Leptodactylus bufonius* (Lb), *Leptodactylus elenae* (Le), *Leptodactylus fuscus* (Lf), *Leptodactylus latinasus* (Ll), *Leptodactylus mystaceus* (Lm), *Leptodactylus mystacinus* (Lms) and *Leptodactylus syphax* (Ls). Original records: Argentina (Arg), Brazil (Bra), Ecuador (Ecu), Paraguay (Par) and Peru (Per). Brazilian States: Ceará (CE), Espírito Santo (ES), Mato Grosso do Sul (MS), Pará (PA), Rio de Janeiro (RJ) and Tocantins (TO).

Table 2. Records of helminths associated with leptodactylids of the *Leptodactylus fuscus* group in South American countries, according to Campi  o et al. (2014). TR (Transchaco), CO (Province of Corrientes), MS (State of Mato Grosso do Sul), AS (Assunci  n), CH (Chaco), RC (Province of Remanso Castillo), CN (Province of Concepci  n), SM (Province of Santa Maria), PA (State of Par  ), ES (State of Esp  rito Santo), RJ (State of Rio de Janeiro), TO (State of Tocantins), SCE (Province of Santa Cecilia) and CU (Cuzco).

Host	Parasite	Country	Locality	Reference
<i>Leptodactylus bufonius</i>	<i>Acanthocephalus caspanensis</i>	Paraguay	TR	Smales (2007)
	<i>Centrorhynchus</i> sp.	Argentina	CO	Gonz��lez & Hamann (2006)
	<i>Ortleppascaris</i> sp.	Argentina	CO	Gonz��lez & Hamann (2006)
	<i>Aplectana hylambatis</i>	Argentina	CO	Gonz��lez & Hamann (2006)
	<i>Aplectana</i> sp.	Argentina	CO	Gonz��lez & Hamann (2006)
	<i>Cosmocerca ornata</i>	Brazil	not reported	Baker & Vaucher (1984)
	<i>Cosmocerca parva</i>	Argentina	CO	Gonz��lez & Hamann (2006)
	<i>Cosmocerca podicipinus</i>	Argentina	CO	Gonz��lez & Hamann (2006)
	<i>Physaloptera</i> sp.	Argentina	CO	Gonz��lez & Hamann (2006)
	<i>Oswaldocruzia proencai</i>	Brazil	MS	Vicente et al. (1990)
		Paraguay	AS	Lent et al. (1946)
		Argentina	CH	Lent et al. (1946)
		Paraguay	RC	Lent et al. (1946)
	<i>Oswaldocruzia</i> sp.	Argentina	CO	Gonz��lez & Hamann (2006)
	<i>Rhabdias elegans</i>	Argentina	CO	Gonz��lez & Hamann (2006)
	<i>Schulzia travassosi</i>	Paraguay	CN	Durette-Desset et al. (1986)
		Argentina	not reported	Gonz��lez & Hamann (2015)
	<i>Catadiscus inopinatus</i>	Argentina	CO	Hamann, et al. (2006)
	<i>Glypthelminis repandum</i>	Argentina	CO	Gonz��lez & Hamann (2006)
<i>Leptodactylus elenae</i>	<i>Aplectana delirae</i>	Argentina	CO	Gonz��lez & Hamann (2016)
	<i>Aplectana elenae</i>	Paraguay	not reported	Baker (1987)
	<i>Aplectana hylambatis</i>	Paraguay	not reported	Baker & Vaucher (1986)
	<i>Aplectana paraelenae</i>	Paraguay	not reported	Baker (1987)
	<i>Aplectana</i> sp.	Brazil	MS	Baker & Vaucher (1986)
	<i>Cosmocerca podicipinus</i>	Paraguay	not reported	Baker & Vaucher (1986)
	<i>Cosmocerca parva</i>	Argentina	CO	Gonz��lez & Hamann (2016)
	<i>Oxyascaris oxyascaris</i>	Paraguay	not reported	Baker & Vaucher (1986)
	<i>Schrankiana formosula</i>	Paraguay	not reported	Baker & Vaucher (1988)
	<i>Oswaldocruzia proencai</i>		not reported	Vicente et al. (1990)
<i>Leptodactylus fuscus</i>	<i>Schrankiana formosula</i>	Brazil	PA	Goldberg et al. (2007)
		Brazil	RJ	Freitas, 1959 apud Campi��o et al. (2014)
	<i>Schrankiana fuscus</i>	Brazil	PA	Goldberg et al. (2007)
	<i>Schrankiana larvata</i>	Brazil	PA	Goldberg et al. (2007)
		Brazil	TO	Freitas, 1959 apud Campi��o et al. (2014)
		Brazil	MS	Freitas, 1959 apud Campi��o et al. (2014)
	<i>Aplectana hylambatis</i>	Paraguay	not reported	Baker & Vaucher (1986)
	<i>Aplectana</i> sp.	Brazil	MS	Freitas, 1959 apud Campi��o et al. (2014)
	<i>Cosmocerca parva</i>	Brazil	RJ	Vicente et al. (1990)
	<i>Cosmocerca podicipinus</i>	Brazil	TO	Baker & Vaucher (1986)
	<i>Oxyascaris oxyascaris</i>	Brazil	MS	Baker & Vaucher (1986)
	<i>Oxyascaris caudacutus</i>	Brazil	RJ	Vicente et al. (1990)
	<i>Ochoterenella convoluta</i>	Brazil	not reported	Walton (1935)
	<i>Oswaldocruzia mazzai</i>	Brazil	TO	Goldberg et al. (2009)
<i>Leptodactylus gracilis</i>	<i>Oswaldocruzia vaucheri</i>	Brazil	PA	Goldberg et al. (2007)
	<i>Oswaldocruzia</i> sp.	Brazil	ES	Travassos et al., 1964 apud Campi��o et al. (2014)
	<i>Mesocoelium monas</i>	Brazil	RJ	Rodrigues et al. (1990)
	<i>Strongyloides carinii</i>	Brazil	not reported	Pereira, 1935 apud Campi��o et al. (2014)

Table 2. Continued...

Host	Parasite	Country	Locality	Reference
<i>Leptodactylus latinasus</i>	<i>Schrankiana schranki</i>	Argentina	CO	Hamann et al. (2006)
	<i>Aplectana hylambatis</i>	Argentina	CO	Hamann et al. (2006)
	<i>Cosmocerca cruzi</i>	Argentina	CO	Hamann et al. (2006)
	<i>Cosmocerca parva</i>	Argentina	CO	Hamann et al. (2006)
	<i>Cosmocerca podicipinus</i>	Argentina	CO	Hamann et al. (2006)
	<i>Cosmocerca rara</i>	Argentina	CO	Hamann et al. (2006)
	<i>Bursotrema</i> aff. <i>tetracotylodes</i>	Argentina	CO	Hamann et al. (2006)
	<i>Catadiscus inopinatus</i>	Argentina	CO	Hamann et al. (2006)
	<i>Petasiger</i> sp.	Argentina	CO	Hamann et al. (2006)
	<i>Styphlodora</i> sp.	Argentina	CO	Hamann et al. (2006)
	<i>Travtrema</i> aff. <i>stenocotyle</i>	Argentina	CO	Hamann et al. (2006)
	<i>Glypthelminis repandum</i>	Argentina	CO	Hamann et al. (2006)
	<i>Haematoloechus longiplexus</i>	Argentina	CO	Hamann et al. (2006)
	<i>Opisthogonimus</i> sp.	Argentina	CO	Hamann et al. (2006)
<i>Leptodactylus mystaceus</i>	<i>Aplectana membranosa</i>	Brazil	RJ	Rodrigues (1986)
	<i>Aplectana travassosi</i>	Ecuador	SCE	Dyer (1990)
	<i>Cosmocerca parva</i>	Brazil	RJ	Fabio, 1982 apud Campião et al. (2014)
		Peru	CU	Burse et al. (2001)
	<i>Mesocoelium monas</i>	Brazil	RJ	Fabio, 1982 apud Campião et al. (2014)
	<i>Oxyascaris caudacutus</i>	Brazil	RJ	Fabio, 1982 apud Campião et al. (2014)
	<i>Oxyascaris oxyascaris</i>	Brazil	RJ	Fabio, 1982 apud Campião et al. (2014)
	<i>Oswaldocruzia proencai</i>	Ecuador	SCE	Dyer & Altig (1977)
	<i>Physaloptera</i> sp.	Brazil	RJ	Fabio, 1982 apud Campião et al. (2014)
		Peru	CU	Burse et al. (2001)
	<i>Physalopteroides venancioi</i>	Peru	CU	Burse et al. (2001)
	<i>Schrankiana freitasi</i>	Brazil	PA	Goldberg et al. (2007)
	<i>Schrankiana larvata</i>	Brazil	TO	Goldberg et al. (2009)
		Peru	CU	Burse et al. (2001)
<i>Leptodactylus mystacinus</i>	<i>Centrorhynchus</i> sp.	Brazil	RJ	Fabio, 1982 apud Campião et al. (2014)
	<i>Aplectana hylambatis</i>	Paraguay	not reported	Baker & Vaucher (1986)
	<i>Aplectana macintoshii</i>	Paraguay	not reported	Baker & Vaucher (1986)
	<i>Aplectana</i> sp.	Brazil	MS	Travassos, 1925 apud Campião et al. (2014)
	<i>Cosmocerca ornata</i>	Paraguay	not reported	Baker & Vaucher (1986)
	<i>Oxyascaris oxyascaris</i>	Brazil	MS	Travassos, 1925 apud Campião et al. (2014)
	<i>Mesocoelium monas</i>	Brazil	RJ	Freitas, 1967 apud Campião et al. (2014)
<i>Leptodactylus syphax</i>	<i>Aplectana</i> sp.	Brazil	MS	Vicente et al. (1990)

that this helminth was acquired through ingestion of arthropods. Some species of Acanthocephala are found in amphibians: in most cases, the cystacanths adhered to the mesentery for transportation by an anuran from an aquatic intermediary host to an aquatic predatory bird, for example (KENNEDY, 2006).

Metacercariae of *Lophosicyadiplostomum* were reported for the first time in a frog of the family Leptodactylidae, in the present study. They were found in the kidneys, thus corroborating previous studies in which this digenean was reported in cyst form at this same infection site. Many digeneans parasitize amphibians: for example, the *L. fuscus* group includes *L. latinasus* (HAMANN et al., 2006), which has been reported to be infected by both aquatic and terrestrial parasites. Metacercariae of *Lophosicyadiplostomum* aff. *nephrocystis* were found in the kidneys of *Scinax nasicus*, (HAMANN

& GONZÁLEZ, 2009), *Hyla nana* and *Lysapsus limellum* (HAMANN & KEHR, 1998, 1999). Infection with this trematode may have occurred by penetration of cercariae beyond the host's cloaca, subsequently reaching the kidneys. On the other hand, considering the life cycle of Diplostomidae, gastropods could be ingested by anurans and then the larvae could reach anurans' kidneys as reported by Gonzalez & Hamann (2006).

Most hosts within the *L. fuscus* group have shown similarity regarding the areas sampled, but some species have been grouped according to helminth species that they share (Figure 1). The helminth fauna of *L. syphax* in the Caatinga was most similar to that of *L. mystaceus* and *L. fuscus*, in different regions, because they shared three nematode species. Nematodes generally do not have a specificity pattern, and therefore the ability of parasites to

explore a wider range of hosts results in better use of resources and opportunities for successful biological cycles (POULIN, 2005). The host species in question belong to the same group and do not differ much regarding ecology and physiology, although the sampling points for each host have had very different characteristics, even involving different biomes (e.g. Caatinga, Atlantic Forest, high altitude as in Cuzco, or the Chaco region of Argentina).

Diverse mechanisms for host infection, the low level of general environmental requirements for these helminths and low host specificity allow parasite infection even in completely different environments (SOUSA & GROSHOLZ, 1991). Specimens of *L. syphax* collected from the Caatinga presented a fauna mostly composed of nematodes considering the number of parasites, that were in most cases, parasites with a direct life cycle (ANDERSON, 2000) that did not require intermediate host. The requirement for an intermediate host usually occurs in environments with greater abundance of water. The Caatinga has extremely low rainfall, with a very long dry season (DUELLMAN, 1999), and consequently there are few environments available for parasites with an indirect life cycle, as opposed to environments from which congeneric species were collected. In addition, *L. syphax* presents a terrestrial habit and active forager, which favors infection by direct life cycle parasites, once this host remains most of its life in the soil.

Knowledge of the helminth fauna associated with vertebrates improves the data on biodiversity and increases the records of occurrences of species of parasites and their relationships with their hosts. This helps expand knowledge of the distribution patterns of these species and aids future studies on ecological host-parasite relationships.

Acknowledgements

Financial support for this study was provided by the Research Support Foundation of the State of São Paulo (Fundação de Amparo a Pesquisa do Estado de São Paulo, FAPESP) (grant no. 2012/24945-1). Robson Waldemar Ávila thanks the National Council for Scientific and Technological Development (Conselho Nacional de Desenvolvimento Científico e Tecnológico, CNPq) for providing a research fellowship (no. 303622/2015-6) and Drausio H. Morais thanks the Coordination Office for Improvement of Higher Education Personnel (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, CAPES) for providing a research fellowship (CAPES/PNPD no. 22005013001P4).

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