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Community ecology of parasites in four species of *Corydoras* (Callichthyidae), ornamental fish endemic to the eastern Amazon (Brazil)

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Abstract: This study compared the parasites community in Corydoras ephippifer, Corydoras melanistius, Corydoras amapaensis and Corydoras spilurus from tributaries from the Amapari River in State of Amapá (Brazil). A total of 151 fish of these four ornamental species were examined, of which 66.2% were parasitized by one or more species, and a total of 732 parasites were collected. Corydoras ephippifer (91.2%) and C. spilurus (98.8%) were the most parasitized hosts, while C. amapaensis (9.6%) was the least parasitized. A high similarity (≅ 75%) of parasite communities was found in the host species. Hosts were parasitized by Procamallanus (Spirocamallanus) inopinatus, Camallanus sp. and metacercariae of digeneans. The parasites had an aggregated dispersion pattern, but in C. ephippifer a random dispersion of P. (S.) inopinatus was found. The parasite community was characterized by a low species richness (1-4 parasites per host), low diversity and low evenness, and consisted mainly of endoparasites with high prevalence and low abundance. An important component in the determination of the helminth parasite community composition was the dominance of species that use these fish species as secondary intermediate or paratenic hosts. This was the first study on the parasite community for these four hosts. A checklist of parasite species in wild populations of Corydoras spp. from different localities was also reported here.

Key words: Amazon, diversity, helminths, parasites, freshwater fish.

INTRODUCTION

Corydoras Lacépède, 1803 (Callichthyidae) are siluriforms fish distributed in part of South and Central America, but they are most abundant in the Amazonas River basin. In general, *Corydoras* spp. are benthic fish living associated with sandy or muddy substrates of highly diversified habitats such as rivers, lakes, near to the banks or at shallow depths (Tencatt and Ohara 2016). Omnivorous fish, feed on invertebrates such as aquatic worms, microcrustaceans, insects, insect larvae and eggs, mollusks and possibly algae and plants (Froese and Pauly 2018). Several species of *Corydoras* have economic importance for the ornamental

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fish market (Rodríguez-Ithurralde et al. 2014). No species of *Corydoras* is listed as "Least Concern" by the IUCN.

Corydoras ephippifer Nijssen, 1972, *Corydoras melanistius* Regan, 1912, *Corydoras amapaensis* Nijssen, 1972 and *Corydoras spilurus* Norman, 1926, have endemic distribution in the eastern Amazon region. *Corydoras ephippifer* is found in some hydrographic basins in the state of Amapá (northern Brazil), while *C. melanistius* is distributed in basins from Suriname, French Guiana and some basins in the state of Amapá. *Corydoras amapaensis* is found in tributaries of the rivers Amapari and Oiapoque in the state of Amapá (Brazil), and in rivers from the French Guiana. *Corydoras spilurus* have distribution known in Approuagua River in French Guiana and Suriname River, in Suriname (Froese and Pauly 2018), but also in tributaries from the Amapari River in the state of Amapá.

The capture and transport of Amazonian wild ornamental fish can cause stress due to inadequate management, which can lead to parasitic infections and high mortality rates of host populations. These fish presents a peculiar fauna of parasites and when captured and kept in culture with high population density, they may present high rates of parasitic infections (Ferraz 1999, Tavares-Dias et al. 2010, Aguinaga et al. 2015, Hoshino et al. 2018). Parasites, an inseparable component of the environment, are often the major cause of mortality and elimination of fish by the ornamental fishery (Ferraz 1999, Tavares-Dias et al. 2010, Aguinaga et al. 2015), which represents high biological losses. Thus, considering the importance of parasites, studies on these organisms can serve as basis for a series of investigations, such as parasite-induced pathology, use of parasites as bioindicators of water quality, ecological and economic impacts caused by invasive species and their parasites, etc. (Ferraz and Sommerville 1998, Tavares-Dias et al. 2010, Mathews et al. 2015, Hoshino et al. 2018). In addition, it is necessary to study the parasites in hosts of ecosystems that were not investigated previously. The aim of this study was to compare the parasite community of *C. melanistius*, *C. ephippifer*, *C. amapaensis* and *C. spilurus*, fish endemic to eastern Amazon (northern Brazil).

MATERIALS AND METHODS

FISH AND COLLECTION AREA

From July to December 2016, 52 *Corydoras melanistius*, 38 *C. ephippifer*, 31 *C. amapaensis* and 30 *C. spilurus* were collected in the Água Fria River (Figure 1), a tributary of the Amapari River basin, in the municipality of Pedra Branca do Amapari, state of Amapá (Brazil). For parasitological analysis, all fish were collected using hand nets because these tributaries of the Amapari River present large floodplain areas, with very peculiar characteristics, since they are strongly influenced by high rainfall in the Amazon region. These are then highly complex river systems and regulation is a process that affects the integrity of the river-floodplain system. This study was developed in accordance with the principles recommended by the Colégio Brasileiro de Experimentação Animal (Cobea) and with the authorization from Comissão de Ética no Uso de Animais of the Embrapa Amapá (Number 005 - CEUA/CPAFAP) and SISBIO (Number 23276-1).

COLLECTION AND ANALYSIS OF PARASITES

Each fish was weighed (g) and measured for total length (cm) and then necropsied for analysis and collection of ectoparasites and endoparasites. The mouth, gills, opercula and fins were examined for the presence of ectoparasites, and the viscera and gastrointestinal tract, for the presence of endoparasites. The collection, fixation, counting, preparation and staining of parasites for identification followed previous recommendations of Eiras et al. (2006).

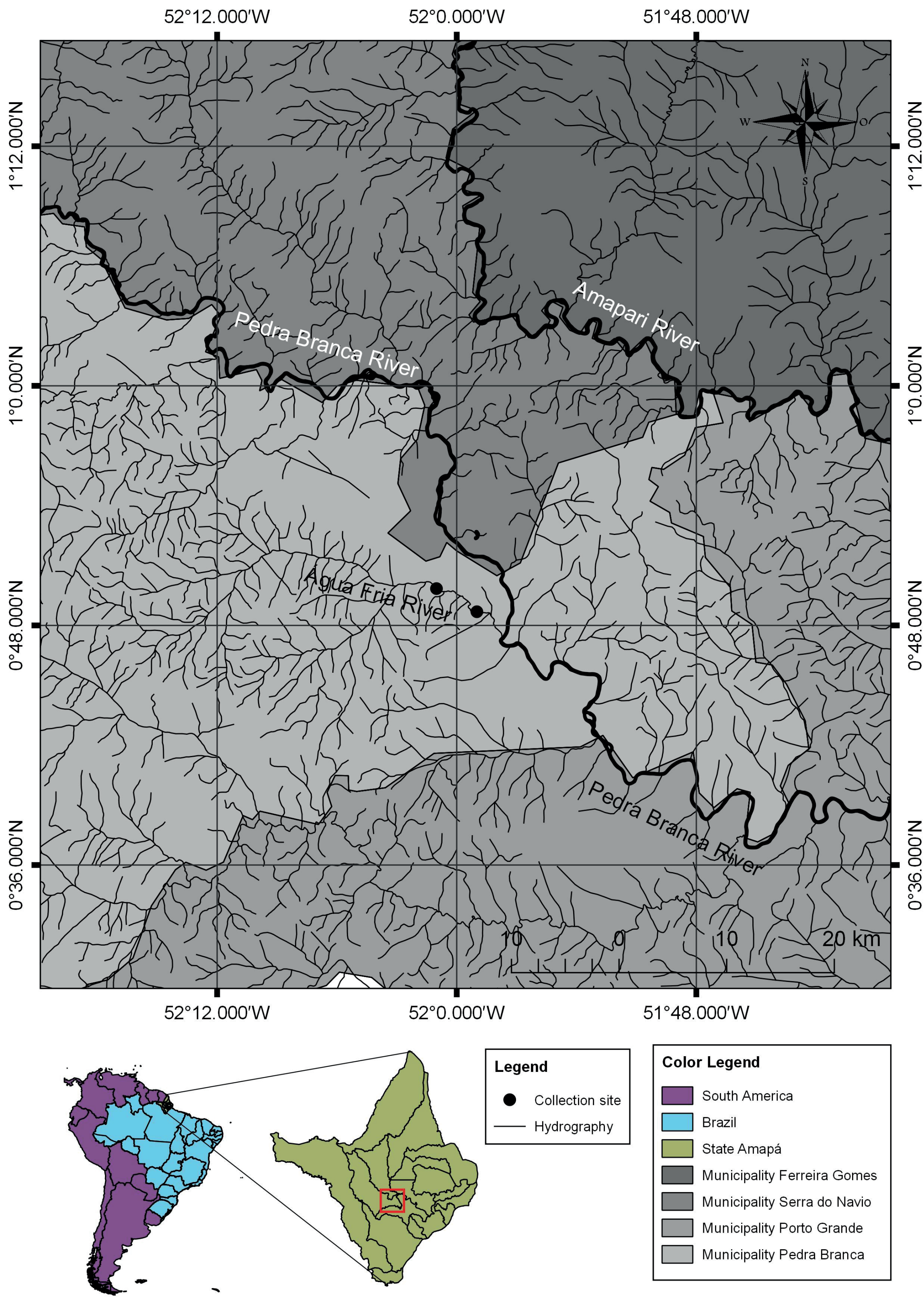

Figure 1 - Collection site of the four species of *Corydoras* endemic to the eastern Amazon (Brazil).

The ecological terms used followed previous recommendations of Bush et al. (1997). The following descriptors for the parasite community were calculated: the species richness, the Shannon diversity index (*H*), evenness (*E*) in association with diversity index, and the Berger-Parker dominance index (*d*) and dominance frequency (percentage of infracommunities in which a parasite species is numerically dominant) (Rohde et al. 1995, Magurran 2004), using the Diversity software (Pisces Conservation Ltd., UK). The dispersion index (ID) and discrepancy index (D) were calculated using the software Quantitative Parasitology 3.0, in order to detect the distribution pattern of parasite infracommunities (Rózsa et al. 2000), for species with prevalence >10%. The significance of ID, for each infracommunity, was tested using the *d*- statistics (Ludwig and Reynolds 1988). The Spearman correlation coefficient (*rs*) was used to determine possible correlations of length with parasite abundance, species richness, and Shannon diversity (Zar 2010).

To test the differences between the parasite communities of *C. ephippifer*, *C. melanistius*, *C. amapaensis* and *C. spilurus*, the ANOSIM test was applied with 999 permutations using the Jaccard (J) similarity index (presence/absence of species), and dissimilarity index of Bray-Curtis (B) (abundance) (Hammer et al. 2001).

RESULTS

In *C. ephippifer*, *C. melanistius*, *C. amapaensis* and *C. spilurus,* the total parasitic prevalence varied from 9.6 to 96.8%, but *C. ephippifer* and *C. spilurus* were the hosts most parasitized, while C. *amapaensis* was the least parasitized (Table I). The nematodes *Procamallanus* (*Spirocamallanus*) *inopinatus* Travassos, Artigos & Pereira and *Camallanus* Railliet and Henry, 1915 and encysted metacercariae of Digenea were common parasites for the four species of *Corydoras* and were the dominant parasites. *Gyrodactylus* von Nordmann, 1832 occurred only in *C. ephippifer* and pentastomid larvae occurred only in *C. spilurus* (Table II).

The parasites exhibited an aggregated dispersion pattern, but *P.* (*S.*) *inopinatus* had a random dispersion pattern in *C. ephippifer* (Table III).

The mean values of parasite species richness, Shannon diversity and evenness were lowest in *C. amapaensis* (Table IV). The body length of *C. melanistius* had no correlation with the Shannon diversity index (*rs* = 0.228, p = 0.115) and species richness of parasites (*rs* = 0.143, p = 0.326). The body length of *C. ephippifer* showed no correlation with the Shannon diversity index (*rs* = 0.008, p = 0.965) and species richness of parasites (*rs* = -0.068, p = 0.699).

The body length of *C. ephippifer* was not correlated with the abundance of *P.* (*S.*) *inopinatus* (*rs* = -0.212, p = 0.220), *Camallanus* sp. (*rs* = -0.031, p = 0.860) and undetermined digenean metacercariae (*rs* = 0.069, p = 0.693). The length of *C. melanistius* showed no correlation with the abundance of *P.* (*S.*) *inopinatus* (*rs* = 0.121, p = 0.408), *Camallanus* sp. (*rs* = 0.068, p = 0.645) and undetermined digenean metacercariae (*rs* = 0.221, p = 0.144). The length of *C. spilurus* showed no correlation with the abundance of *P.* (*S.*) *inopinatus* (*rs* = -0.260, p = 0.157) and *Camallanus* sp. (*rs* = -0.126, p = 0.498), but a weak correlation with the abundance of digenean metacercariae (*rs* = -0.363, p = 0.044).

Similarity of component communities of host populations exhibited qualitative and quantitative homogeneity (Table V). ANOSIM detected no spatial difference in the composition and abundance of parasite species between populations of the four host species ($R_{Jaccard}$= 0.112, p = 0.0001; $R_{Bray\text{-}Curtis}$= 0.196; p =0.0001).

In *C. melanistius* and *C. ephippifer*, there was a predominance of hosts infected with one parasite species, while for *C. amapaensis* the predominance was of uninfected hosts and *C. spilurus* was of hosts infected with two species of parasites (Figure 2).

TABLE I
Total parasitological indices in four species of *Corydoras* endemic to the eastern Amazon (Brazil).

Indices	*C. ephippifer*	*C. melanistius*	*C. amapaensis*	*C. spilurus*
Examined fish	38	52	31	30
Parasitized fish	35	38	3	24
Prevalence (%)	91.2	73.1	9.6	96.8
Total number of parasites	221	127	6	378

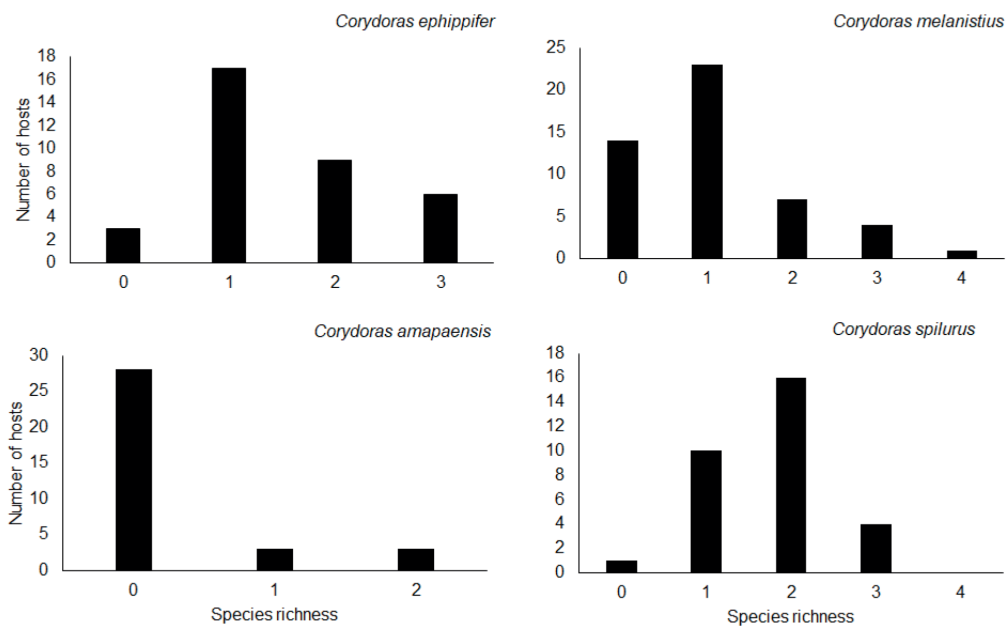

Figure 2 - Species richness of parasites for four species of *Corydoras* endemic to the eastern Amazon (Brazil).

DISCUSSION

Some species of parasites are known by infecting *Corydoras* spp. from different localities, of which 8 are species of Monogenea, 2 Nematoda, 3 Myxozoa, 2 Crustacea, 2 Protozoa and 2 Acanthocephala. Therefore, the dominance is of ectoparasites species (Table VI). However, none of these parasite species was found in *C. ephippifer*, *C. melanistius*, *C. amapaensis* and *C. spilurus* from the eastern Amazon. Thus, the parasite species found herein are the first records for these four host species from the eastern Amazon. In addition, for *C. ephippifer*, *C. melanistius*, *C. amapaensis* and *C. spilurus*, there was a dominance of nematodes *P.* (*S.*) *inopinatus* and *Camallanus* sp. The host specificity is not an important factor in the distribution of *P.* (*S.*) *inopinatus*, a generalist nematode species that infects different wild fish species from Brazil. On the other hand, Salgado-Maldonado et al. (2016) stated that the distribution of helminths may reflect that of the tropical fish families they parasitize.

A similarity in the parasite component community in *C. melanistius*, *C. spilurus*, *C. ephippifer* and *C. spilurus* was found because they are wild host populations of the same environment. However, Krasnov et al. (2012) reported that the environmental dissimilarity between host

TABLE II

Parasites in four species of *Corydoras* endemic to the eastern Amazon (Brazil).

Corydoras ephippifer						
Indices	***Procamallanus (S.) inopinatus***	***Camallanus* sp.**	**Digenea**	**Digenea**	***Gyrodactylus* sp.**	**Pentastomida**
Sites of infection	Intestine	Intestine	Gills	Intestine	Gills	Intestine
Prevalence (%)	68.6	34.3	8.6	37.1	5.7	0
Mean intensity	2.5	7.2	1.3	5.3	2	0
Mean abundance	1.7	2.5	0.1	2.0	0.1	0
Range	1-7	1-22	1-2	1-19	2-2	0
Total number of parasites	60	86	4	69	2	0
Frequency of dominance	0.27	0.39	0.02	0.31	0.009	0
Corydoras melanistius						
Sites of infection	Intestine	Intestine	Gills	Intestine	Gills	Intestine
Prevalence (%)	26.5	40.8	16.3	24.5	0	0
Mean intensity	3.0	3.2	1.0	1.2	0	0
Mean abundance	0.8	1.3	0.2	1.3	0	0
Range	1-9	1-19	1-1	1-3	0	0
Total number of parasites	39	64	8	16	0	0
Frequency of dominance	0.31	0.50	0.06	0.13	0	0
Corydoras amapaensis						
Sites of infection	Intestine	Intestine	Gills	Intestine	Gills	Intestine
Prevalence (%)	68.6	6.5	0	3.2	0	0
Mean intensity	3.0	1.0	0	1.0	0	0
Mean abundance	0.10	0.06	0	0.03	0	0
Range	1-3	1-1	0	1-1	0	0
Total number of parasites	3	2	0	1	0	0
Frequency of dominance	0.50	0.33	0	0.17	0	0
Corydoras spilurus						
Sites of infection	Intestine	Intestine	Gills	Intestine	Gills	Intestine
Prevalence (%)	77.4	67.7	0	25.8	0	3.2
Mean intensity	2.8	11.1	0	9.50	0	1
Mean abundance	2.2	7.5	0	2.5	0	0.03
Range	1-9	1-60	0	1-32	0	1
Total number of parasites	67	234	0	76	0	1
Frequency of dominance	0.18	0.62	0	0.20	0	0.003

TABLE III
Index of dispersion (ID), *d*-statistic and discrepancy index (D) for the parasite infracommunities of four species of *Corydoras* endemic to the eastern Amazon (Brazil).

Host fish	*C. ephippifer*			*C. melanistius*			*C. spilurus*			*C. amapaensis*		
Species of parasites	ID	*d*	D	ID	*d*	D	ID	*d*	D	ID	*d*	D
Procamallanus (*S.*) *inopinatus*	1.10	0.48	0.46	2.53	5.85	0.79	2.56	4.72	0.52	2.673	6.78	0.77
Camallanus sp.	3.06	6.64	0.75	2.50	5.75	0.72	27.29	32.8	0.73	-	-	-
Digenea gen. sp. (intestine)	1.75	2.72	0.69	1.12	0.61	0.82	17.29	24.52	0.84	-	-	-
Digenea gen. sp. (gills)	-	-	-	0.85	0.69	0.78	-	-	-	-	-	-

TABLE IV
Diversity descriptors and body parameters for parasite communities in four species of *Corydoras* endemic to the eastern Amazon (Brazil).

Parameters	*C. ephippifer*	*C. melanistius*	*C. amapaensis*	*C. spilurus*
Weight (g)	2.7 ± 0.9 (1.3-4.8)	2.2 ± 0.4 (1.6-3.3)	5.9 ± 1.7 (2.6-8.6)	3.6 ± 1.01 (1.83-5.5)
Length (cm)	5.5 ± 0.6 (4.6-6.8)	4.8 ± 0.3 (4.03-5.5)	7.1 ± 0.7 (5.6-8.2)	5.8 ± 0.6 (4.8-6.8)
Parasite species richness	1.51 ± 0.89 (0-3)	1.08 ± 0.98 (0-4)	0.13 ± 0.43 (0-2)	1.74 ± 0.73 (0-3)
Shannon index	0.26 ± 0.34 (0-1.05)	0.19 ± 0.35 (0-1.31)	0.022 ± 0.12 (0-0.69)	0.36 ± 0.33 (0-1.76)
Evenness	0.16 ± 0.21 (0-0.65)	0.13 ± 0.25 (0-95)	0.020 ± 0.11 (0-0.63)	0.26 ± 0.24 (0-0.77)

TABLE V
Pairwise similarity index of parasite component community in four species of *Corydoras* endemic to the eastern Amazon (Brazil).

Pairwise	*C. ephippifer*	*C. melanistius*	*C. amapaensis*	*C. spilurus*
		Jaccard index		
C. ephippifer	-	0.75	0.75	0.60
C. melanistius	0.75	-	0.75	0.80
C. amapaensis	0.75	0.75	-	0.60
C. spilurus	0.75	0.80	0.75	-
	C. ephippifer	*C. melanistius*	*C. amapaensis*	*C. spilurus*
		Bray-Curtis index		
C. ephippifer	-	0.71	0.05	0.72
C. melanistius	0.70	-	0.09	0.44
C. amapaensis	0.05	0.09	-	0.03
C. spilurus	0.72	0.44	0.03	-

TABLE VI
List of parasites in wild populations of *Corydoras* spp. from different localities.

Host fish	Parasite species	Locality	References
Corydoras aeneus Gill, 1858	*Procamallanus* (*Spirocamallanus*) *pintoi* Kohn & Fernandes, 1988	Venezuela	Moravec et al. (1997)
	Philocorydoras corydori Molnar, Hanek et Fernando, 1974	Trinidad	Molnar et al. (1974)
	Philocorydoras margolisi Molnar, Hanek et Fernando, 1974	Trinidad	Molnar et al. (1974)
Corydoras paleatus Jenyns, 1842	*Procamallanus* (*Spirocamallanus*) *pintoi* Kohn & Fernandes, 1988	Brazil	Kohn and Fernandes 1988, Moravec et al. (1999), Ito et al. (2005)
		Peru	Moravec et al. (1999)
Corydoras reticulatus Fraser-Brunner, 1938	*Piscinoodinium pillulare* Schäperclaus, 1954	Colombia, Brazil	Ferraz and Sommerville (1998)
Corydoras paleatus Jenyns, 1842	Neoechinorhynchus villoldoi Vizcaíno, 1992	Argentina	Vizcaino (1992)
	Lernaea cyprinacea Linnaeus, 1758	Argentina	Plaul et al. (2010)
	Philocorydoras platensis Suriano, 1986	Argentina	Suriano (1986)
	Gyrodactylus superbus Szidat, 1973	Brazil	Popazoglo and Boeger (2000)
	Gyrodactylus samirae Papazoglo & Boeger, 2000	Brazil	Popazoglo and Boeger (2000)
	Gyrodactylus anisopharynx Papazoglo & Boeger, 2000	Brazil	Popazoglo and Boeger (2000)
		Brazil	Bueno-Silva and Boeger (2009)
	Gyrodactylus corydori Bueno-Silva & Boeger, 2009	Brazil	Bueno-Silva and Boeger (2009)
	Trichodina corydori Marcotegui, Basson & Martorelli	Argentina	Marcotegui et al. (2016)
Corydoras schwartzi Rössel, 1963	*Gyrodactylus anisopharynx* Popazoglo & Boeger, 2000	Brazil	Boeger et al. (2005)
	Gyrodactylus corydori Bueno-Silva & Boeger, 2009	Brazil	Bueno-Silva and Boeger (2009)
	Piscinoodinium pillulare Schäperclaus, 1954	Colombia, Brazil	Ferraz and Sommerville (1998)
	Ascarophis sp.	Brazil	Moravec et al. (1999)
Corydoras ehrhardti Steindachner, 1910	*Gyrodactylus superbus* Szidat, 1973	Brazil	Popazoglo and Boeger (2000)
	Gyrodactylus samirae Papazoglo & Boeger, 2000	Brazil	Popazoglo and Boeger (2000)
	Gyrodactylus anisopharynx Papazoglo & Boeger, 2000	Brazil	Bueno-Silva and Boeger (2009)
	Minilernaea floricapitella Thatcher & Huergo	Brazil	Tozato (2011)
Corydoras melanistius Regan, 1912	*Silurodescoides exotica* Rastogi, Mishra, Rastogi, Sharmaand & Singh, 2008	India	Rastogi et al. (2008)
	Piscinoodinium pillulare Schäperclaus, 1954	Colombia, Brazil	Ferraz and Sommerville (1998)
Corydoras melini Lönnberg & Rendahl, 1930	*Myxidium amazonense* Mathews, Silva, Maia & Adriano, 2015	Brazil	Mathews et al. (2015)
	Henneguya melini Mathews, Maia & Adriano, 2016	Brazil	Mathews et al. (2016)

TABLE VI (continuation)

Host fish	Parasite species	Locality	References
Corydoras leucomelas Eigenmann & Allen, 1942	*Henneguya loreotoensis* Mathews, Naldoni & Adriano, 2017	Peru	Mathews et al. (2017)
Corydoras agassizii Steindachner, 1876	*Piscinoodinium pillulare* Schäperclaus, 1954	Colombia, Brazil	Ferraz and Sommerville (1998)
Corydoras arcuatus Elwin, 1938		Colombia Brazil	Ferraz and Sommerville (1998)
Corydoras punctatus Bloch, 1794		Colombia and Brazil	Ferraz and Sommerville (1998)
Corydoras metae Eigenmann, 1914		Colombia and Brazil	Ferraz and Sommerville (1998)
	Procamallanus (*Spirocamallanus*) *pintoi* Kohn & Fernandes, 1988	Colombia	Santana-Piñeros et al. (2017)
Corydoras sterbai Knaack, 1962	*Piscinoodinium pillulare* Schäperclaus, 1954	Colombia and Brazil	Ferraz and Sommerville (1998)
Corydoras robineae Burgess, 1983		Colombia and Brazil	Ferraz and Sommerville (1998)
Corydoras pygmaeus Knaack, 1966		Colombia and Brazil	Ferraz and Sommerville (1998)
Corydoras hastatus Eigenmann & Eigenmann, 1888		Colombia and Brazil	Ferraz and Sommerville (1998)
Corydoras maculifer Nijssen & Isbrücker, 1971		Colombia, Brazil	Ferraz and Sommerville (1998)
Corydoras elegans Steindachner, 1876		Colombia, Brazil	Ferraz and Sommerville (1998)
Corydoras haraldschultzi Knaack, 1962		Colombia, Brazil	Ferraz and Sommerville (1998)
Corydoras julii Steindachner, 1906	*Neoechinorhynchus* sp.	Brazil	Moravec et al. (1999)

populations are the best predictors of dissimilarity between parasite faunas. Infracommunities with low rates of colonization, low numbers of species and individuals, and with low or no interspecific interactions is a common pattern in freshwater fish populations (Bautista-Hernández et al. 2014). The species richness of parasites, Shannon diversity index and evenness were lowest in *C. amapaensis* compared to *C. ephippifer*, *C. melanistius* and *C. spilurus*, which had few ectoparasites and a predominance of endoparasites. This higher diversity of endoparasites (*P.* (*S.*) *inopinatus* and *Camallanus* sp.) seems to reflect environmental conditions that were favorable to the transmission of parasites, which require intermediate hosts. Moreover, this predominance of endoparasites may be related to the life style of these omnivorous fish that occupy low levels in the food web, feeding mainly on invertebrates, such as aquatic worms, microcrustaceans, insects, larvae, insect eggs and mollusks (Froese and Pauly 2018).

A fundamental aspect of the host-parasite interaction is related to the distribution pattern of parasites among hosts. The distribution of parasites in freshwater fish is typically aggregated (Guidelli et al. 2003, Poulin 2013, Amarante et al. 2015, Oliveira and Tavares-Dias 2016). The aggregated dispersion of parasites has been attributed to the heterogeneity of the environment and to susceptibility of the host population to the parasites

(Poulin 2013). Thus, aggregated dispersion pattern of parasites in *C. ephippifer*, *C. melanistius* and *C. spilurus* was found, as expected. In contrast, the dispersion of *P.* (*S.*) *inopinatus* in *C. ephippifer* was random, a distribution pattern that occurs mainly in parasite species with moderate or high pathogenicity and with low ability for colonizing hosts in environments (Guidelli et al. 2003, Oliveira and Tavares-Dias 2016).

In the Neotropical region, 39 species of Gyrodactylidae of 18 *Gyrodactylus* are known (Bueno-Silva and Boeger 2009). Gyrodactylids exhibit extraordinary species diversity and broad host range, because this evolutionary success is associated with a suite of morphological and life-history traits that include, in part, continuous transmission, i.e., ability to infect new hosts throughout their direct life cycle (Boeger et al. 2005). Monogeneans *Gyrodactylus* sp. were found only in the gills of *C. ephippifer* and at low levels of infection. Usually, these low levels of monogeneans in wild fish are not pathogenic, since they seem to be in balance with their hosts. *Gyrodactylus anisopharynx*, *G. corydori*, *G. superbus*, *G. samirae* are known species of monogeneans infecting *Corydoras* spp. (Table VI). However, these ectoparasites of *C. ephippifer* do not seem any of these species of monogeneans.

Pentastomid are endoparasites mainly of crocodilian reptiles and aquatic turtles, their main definitive hosts. Fish are intermediate hosts for those species that infect such reptiles (Giesen et al. 2013, Christoffersen and Assis 2013). Only one pentastomid larva was found in the intestine of *C. spilurus* and that may be accidental. However, the infection levels of these endoparasites vary among host fish species (Giesen et al. 2013). Although the pentastomid species was not identified, Giesen et al. (2013) reported that two Sebekidae genera from fish intermediate hosts are known for Brazil: *Leiperia gracilis* Diesing, 1836 and *Sebekia oxycephala* Diesing, 1835, which infected species of Serrasalmidae, Erythrinidae, Pimelodidae and Poeciliidae. However, the pentastomid of *C. spilurus* seem be of the genus *Sebekia*. Abiotic and biotic factors have been also associated with the diversity and abundance of helminths in wild fish populations (Bautista-Hernández et al. 2014, Salgado-Maldonado et al. 2016, Oliveira and Tavares-Dias 2016).

Undetermined digenean metacercariae occurred in gills and intestine of hosts in this study and at low infection levels. To the best of our knowledge, no digenean species has been reported for *Corydoras* spp. (Table VI). However, in *C. melanistius*, *C. ephippifer* and *C. spilurus*, the highest infection rates were caused by *P.* (*S.*) *inopinatus* and *Camallanus* sp. These infection levels by *P.* (*S.*) *inopinatus* were similar to those reported for *C. paleatus* infected by *P.* (*S.*) *pintoi* (Ito et al. 2005). In contrast, the infection levels were higher than that of *P.* (*S.*) *pintoi* in *C. aeneus* from Venezuela (Moravec et al. 1997) and in *C. paleatus* from the Paraná River (Moravec et al. 1999). Nevertheless, these are different congeneric hosts collected in different ecosystems, which has different environmental conditions.

The abundance of parasites is an important factor that can reduce the weight and length of host fish populations, affecting the body conditions of them (Guidelli et al. 2003, Rolbiecki 2006). No correlation between host length and abundance of parasites was found for *C. ephippifer*, *C. melanistius*, *C. spilurus* and *C. amapaensis*; probably due to the little variation in the length of the hosts. Ito et al. (2005) also reported no correlation between the infection intensity of *P.* (*S.*) *pintoi* with the body length of *C. paleatus* from the Paraná River. This absence of correlation between the host length with the parasites abundance may be indicative that the length of these hosts does not in fact influence the variation in the parasite infracommunities. Nevertheless, correlation between parasites abundance with host body size is far from universal. The host size can either be related or not to its age, once the parasitic population may increase, decrease or not suffer effect from its size and age (Guidelli et al. 2003, Rolbiecki 2006, Oliveira and Tavares-Dias 2016).

CONCLUSIONS

Parasite communities of *C. ephippifer*, *C. melanistius*, *C. spilurus* and *C. amapaensis* were characterized by a high similarity, low species richness, low diversity, low evenness, and composed mainly of endoparasites with high prevalence, low abundance and overdispersion. In these hosts, concurrent infections with two endohelminth parasites were a common occurrence. An important component in the determination of the helminth parasite community composition was the dominance of species that use fish as secondary intermediate or paratenic hosts. Finally, given the importance of ornamental fish as a source of income for people living in this study area, and a possible negative impact of parasites on fish, studies on control and treatment of endoparasite species are necessary.

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