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**Original Article**

# Parasites of ornamental fish commercialized in Macapá, Amapá State (Brazil)

Parasitos de peixes ornamentais comercializados em Macapá, Estado do Amapá (Brasil)

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## Abstract

This study investigated the parasites fauna of four freshwater ornamental fish species in aquarium shops of Macapá, Amapá State, in addition to survey the commercialized fish species and sanitary conditions of aquarium shops. Different native and non-native ornamental fish species were found in aquarium shops, mainly Poecilidae. We examined 30 specimens of *Xiphophorus maculatus*, 30 *Danio rerio*, 30 *Paracheirodon axelrodi*, and 30 *Corydoras ephippifer* for parasites. Of the 120 fish examined, 22.5% were parasitized by one or more species and a total of 438 parasites were collected and identified. Parasites such as: *Ichthyophthirius multifiliis*, Monogenea, undermined Digenea metacercariae, *Acanthostomum* sp. metacercariae, *Camallanus* spp., *Bothriocephalus acheilognathi* and *Echinorhynchus* sp. infected the hosts examined. Endoparasites in the larval stage showed the greatest diversity and *Camallanus* spp. was found in all hosts species examined. *Paracheirodon axelrodi* (43.3%) was the most parasitized host, while *C. ephippifer* (6.7%) was the least parasitized. Despite the low ectoparasites level, six species of endoparasites was observed, demonstrating that prophylactic and quarantine procedures were not fully adequate. Therefore, failures in prophylactic procedures on any link in the production industry of ornamental fish may cause parasite transmission to ornamental fish captured in different environments and localities.

**Keywords:** Culture, ornamental fish, parasites, sanity.

## Resumo

Este estudo investigou a fauna de parasitos de quatro espécies de peixes ornamentais de água doce comercializadas em lojas de aquários de Macapá, estado do Amapá, bem como as espécies de peixes comercializadas e as condições sanitárias dessas lojas. Diferentes espécies de peixes ornamentais nativos e não nativos foram encontradas em lojas de aquários, principalmente Poecilidae. Foram examinados 30 espécimes de *Xiphophorus maculatus,* 30 *Danio rerio,* 30 *Paracheirodon axelrodi* e 30 *Corydoras ephippifer*, para análise de parasitos. Dos 120 peixes examinados, 22,5% estavam parasitados por uma ou mais espécies de parasitos. Foram coletados um total de 438 parasitos tais como: *Ichthyophthirius multifiliis*, Monogenea, metacercárias de Digenea não identificadas, metacercárias de *Acanthostomum* sp., *Camallanus* spp., *Bothriocephalus acheilognathi* e *Echinorhynchus* sp. A maior diversidade foi de endoparasitos em estágio larval e *Camallanus* spp. foi encontrado em todas as espécies de hospedeiros examinados. *Paracheirodon axelrodi* (43,3%) foi o hospedeiro mais parasitado, enquanto *C. ephippifer* (6,7%) o menos parasitado. Apesar do baixo ectoparasitismo, foram encontradas seis espécies de endoparasitos, demonstrando que os procedimentos profiláticos e a quarentena não foram adequados. Portanto, falhas nos procedimentos profiláticos em qualquer elo da cadeia produtiva de peixes ornamentais pode causar riscos de transmissão de parasitos para peixes de diferentes ambientes e localidades.

**Palavras-chave:** Cultivo, peixe ornamental, parasitos, sanidade.

## Introduction

Ornamental fish keeping is one of the most popular hobbies around the world and has resulted in a turnover of US$ 100 billion in 2015, and continues to grow annually (ABIDI et al., 2011; FARIA et al., 2016). In Brazil, ornamental fish keeping is a very important sector and this endeavor generated an income of US$ 16.7 billion in 2014 (FARIA et al., 2016). Ornamental fish are a significant source of income for many riverine communities from the Amazon basin and aquaculture ventures elsewhere in Brazil. More than 90% of the freshwater ornamental fish sold in Brazil are bred in captivity (SOMMERVILLE et al., 2016; FARIA et al., 2016). However, the

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local trade and export of ornamental fish by Brazilian aquaculture ventures has been inhibited by poor quality and the lack of a regular production process. Singapore is the largest exporter of ornamental fish followed by the Spain and Japan, while Brazil ranks eighth in exports with US $ 13.5 million (FARIA et al., 2016). Although the ornamental fish industry in Brazil has great potential for growth and development, one of the weakest links is a complete lack of understanding of the different diseases that affect ornamental fish farming.

The recent development of ornamental fish industry, not only for export, but also for domestic supply, has attracted the attention of researchers and interested enterprises. Thus, aquaculture and the propagation of ornamental fish are sectors that have increased during recent decades in Brazil. Brazilian ornamental fish are acknowledged around the world for their beautiful appearance, their small size, and easy maintenance. It is widely recognized that the transport of ornamental fish may cause the spread of pathogens and diseases from one country to another (ALVES et al., 2000; ABIDI et al., 2011; MEHRDANA et al., 2014; SALGADO-MALDONADO et al., 2015), and this is due to a great extent in faulty sanitary management. However, the manifestation of these diseases occurs only when the parasites have favorable situations for their proliferation. These conditions tend to be: environmental stress, poor culture conditions, inadequate transportation, stocking density, and poor nutrition (PIAZZA et al., 2006; TAVARES-DIAS et al., 2009; GARCIA et al., 2009; TAVARES-DIAS et al., 2010; ABIDI et al., 2011; MARTINS et al., 2012; MOYSES et al., 2015). The inadequate sanitary management conditions cited above can cause economic losses and frustration among producers. In addition, diseases in ornamental fish has a particular importance because it may cause discoloration, change of body shape, and decreased growth, any of which may compromise their trade value.

Knowledge about diseases affecting ornamental fish and the parasites that infect them is crucial for success in the ornamental fish industry. Many of the economic losses occurring in the aquarium industry are generally caused by protozoan and metazoan species. Some ectoparasites, especially *Ichthyophthirius multifiliis* Fouquet, 1876, *Trichodina* spp. and monogeneans (PIAZZA et al., 2006; TAVARES-DIAS et al., 2009; GARCIA et al., 2009; KOYUNCU, 2009; MOYSES et al., 2015), are found infecting ornamental fish species. Parasitic diseases are harmful and pose limiting factors in the rearing of ornamental fish. Nevertheless, several parasitological surveys (ALVES et al., 2000; PIAZZA et al., 2006; TAVARES-DIAS et al., 2009; KOYUNCU, 2009; GARCIA et al., 2009; MEHRDANA et al., 2014; MOYSES et al., 2015; FLORINDO et al., 2017) have been performed on freshwater ornamental fish and these studies verify a very diverse set of parasitic species. However, none of these surveys include aquarium fish cultured in the State of Amapá, (Brazil). Thus, the purpose of this study is to survey the parasites infecting *Xiphophorus maculatus* Günther, 1866, *Danio rerio* Hamilton, 1822, *Paracheirodon axelrodi* Schultz, 1956 and *Corydoras ephippifer* Nijssen, 1972, which are commercialized in aquarium shops in Macapá, Amapá State. It is also very important to investigate the farmed ornamental fish species and whether management or environmental conditions are responsible for the parasites found in these hosts.

## Materials and Methods

### *Characteristics of the aquarium pet shops and their sanitary conditions*

In the aquarium shops, each fish ornamental species are maintained in different aquarium of 100 L, and in different stocking densities. The fish are fed daily with ration for ornamental fish. The management practices adopted by the aquarium shops (n = 6) of Macapá, Amapá (northern Brazil) were investigated through survey interviews focused on activity time, traded fish species, quantity traded monthly, fish suppliers, water quality parameters (temperature, pH, conductivity, turbidity, dissolved oxygen and salinity), fish mortality, health problems, and management techniques (quarantine, prophylaxis and antiparasitic treatment).

### *Collection of fish and parasite analysis procedures*

In October of 2015, 30 specimens of *X. maculatus*, 30 *P. axelrodi*, 30 *C. ephippifer,* and 30 *D. rerio* found in aquarium shops in Macapá were collected for parasitological analysis. All fish were transported to the Laboratory of Embrapa Amapá to be analyzed. This study was developed in accordance with the principles recommended by the Brazilian College of Animal Experimentation (COBEA) and with the authorization from Ethics Committee in the Use of Animal of the Embrapa Amapá (Protocol: 005 - CEUA/CPAFAP).

Each fish was measured in length (cm) using a caliper and then they were necropsied to examine the gills to collect ectoparasites, and then to examine the gastrointestinal tract for collection of endoparasites. The fish gills were removed and analyzed under a microscope, and the gastrointestinal tract with a stereomicroscope. The parasites found were fixed in formalin 5%, preserved in 70% ethyl alcohol, quantified, and stained for identification (EIRAS et al., 2006). The ecological terms adopted are those suggested by Bush et al. (1997).

## Results

In the aquarium shops investigated in this study, 17 native fish species are marketed along with non-native ornamental fish (Table 1). There are fourteen aquarium shops in Macapá, and it is estimated that combined, they sell about 10,000 ornamental fish per month. The existence time and duration of these aquarium shops in the market varies from 3 to 30 years. In general, non-native fish are purchased from fish farms originating in the states of São Paulo, Rio de Janeiro, Ceará and/or Pernambuco (Brazil). Native fish species are captured from ornamental fishing areas in the Amazon basin and Amapá State.

In the aquarium shops investigated in this study, the mean temperature of the aquariums was 30.6 ± 0.4° C, pH 8.0 ± 0.5, electric conductivity 1.02 ± 0.98 µs/cm, dissolved oxygen 3.8 ± 1.1 mg/$L^{-1}$, salinity 0.52 ± 0.51 ppt, and turbidity 0 NTU.

Mortality of ornamental fish in aquarium shops and that of their clients, in general occurs and is related to inadequate management practices such as: improper feeding, poor water

quality, failure of prevention techniques, and a general lack of knowledge on the ecology of these ornamental fish species; while high stocking density and inadequate maintenance of the aquariums are the most common causes of mortality. In addition, external factors such as: inadequate fish transportation, and problems with predators (e.g. birds) and diseases such as: ichthyophthiriasis, lerneosis, fungal and bacterial infections play a part and cause fish mortality. Fungicides with acriflavine base (Aqualife®) have been used as bactericides, neomycin sulfate base (Bacter®), and fungicidal drugs such as: methylene blue, malachite green, magnesium sulfate, chloride potassium (Ictio®) and sodium chloride (NaCl) in aquarium shops during quarantine and when problems with parasitosis occur. In addition, on a regular basis, a stabilizer, hydroxymethane sulfinate sodium base (Aquasafe®, Prime and Protect®), is placed in the aquarium water.

The specimens of *X. maculatus* that were examined had 3.6 cm ± 0.5 cm, *P. axelrodi* 2.6 cm ± 0.2 cm, *C. ephippifer* 5.6 cm ± 0.7 cm, and *D. rerio* 3.6 cm ± 0.4 cm in length. Of 120 fish examined, 22.5% (N= 27) were infected by one or more parasite species, and a total of 438 parasites were collected from these hosts. Nematodes *Camallanus* spp. were found in all hosts species examined and the greater parasitic diversity was among the endoparasite species.

There was a variation in the hosts infected (Table 2) and was found of 2-4 parasite species. *Paracheirodon axelrodi* was the most parasitized host, while *C. ephippifer* was the least parasitized host. *Ichthyophthirius multifiliis* occurred only in *X. maculatus* and *P. axelrodi*, while larvae of *Camallanus* spp. were found in all examined hosts (Table 3).

## Discussion

In four of the ornamental fish species commercialized in Macapá (AP), the parasites community was composed of 8 species: 1 species of protozoan and 7 helminths, totaling 2 ectoparasite species and 6 endoparasite species mainly in the larval stage. These results indicates that such fish are intermediate hosts for the endoparasites found, which were acquired by trophic via. In ornamental fish of aquariums that are commercialized in Florianópolis (Santa Catarina State) the parasites community was composed of 10 species (4 protozoans, 1 crustacean, and 5 helminths), totaling 6 species of ectoparasites and 3 of endoparasites (PIAZZA et al., 2006). The difference

**Table 1.** Ornamental fish species commercialized monthly in 6 major aquarium shops from Macapá, Amapá State, Brazil.

| Common name | Origin | Obtainment | Fish species | Total |
|---|---|---|---|---|
| Goldfish | Non-native | Culture | *Carassius auratus* Linnaeus, 1758 | 430 |
| Platy fish | Non-native | Culture | *Xiphophorus maculatus* Günther, 1866 | 350 |
| Green swordtail | Non-native | Culture | *Xiphophorus helleri* Heckel, 1848 | 915 |
| Molly | Non-native | Culture | *Poecilia sphenops* Cuvier & Valenciennes, 1846 | 1,040 |
| Guppy | Native | Culture | *Poecilia reticulata* Peters, 1859 | 365 |
| Angelfish | Native | Wild | *Pterophyllum scalare* Schultze in Lichtenstein, 1823 | 135 |
| Cardinal tetra | Native | Wild | *Paracheirodon axelrodi* Schultz, 1956 | 650 |
| Jewel tetra | Native | Wild | *Hyphessobrycon eques* Steindachner, 1882 | 70 |
| Spotted gourami | Non-native | Culture | *Trichogaster trichopterus* Pallas, 1770 | 44 |
| Pencil fish | Native | Wild | *Nannostomus eques* Steindachner, 1876 | 70 |
| Dwarf gourami | Non-native | Culture | *Colisa lalia* Hamilton, 1822 | 45 |
| Betta | Non-native | Culture | *Betta splendens* Regan, 1910 | 105 |
| Zebrafish | Non-native | Culture | *Danio rerio* Hamilton, 1822 | 960 |
| Oscar | Native | Wild | *Astronotus ocellatus* Spix &Agassiz, 1831 | 19 |
| Carp-koi | Non-native | Culture | *Cyprinus carpio* Linnaeus, 1758 | 214 |
| Tiger barb | Non-native | Culture | *Puntius tetrazona* Bleeker, 1855 | 80 |
| Saddle corydora | Native | Wild | *Corydoras ephippifer* Nijssen, 1972 | 40 |
| Total | - | - | | 5,532 |

**Table 2.** Distribution frequency of parasites in ornamental fish from Macapá aquarium shops, Amapá State, Brazil.

| Host species | *Xiphophorus maculatus* | *Corydoras ephippifer* | *Danio rerio* | *Paracheirodon axelrodi* | Total |
|---|---|---|---|---|---|
| **Parasite species** | | | | | |
| *Ichthyophthirius multifiliis* | 41 | 0 | 0 | 333 | 374 |
| Monogenea gen. sp. | 3 | 0 | 1 | 0 | 4 |
| Encysted metacercariae | 0 | 0 | 1 | 7 | 8 |
| Diplostomidae (metacercariae) | 0 | 0 | 0 | 2 | 2 |
| *Acanthostomum* sp. (metacercariae) | 0 | 0 | 0 | 1 | 1 |
| *Camallanus* spp. (larvae) | 1 | 1 | 19 | 26 | 47 |
| *Bothriocephalus acheilognathi* | 1 | 0 | 0 | 0 | 1 |
| *Echinorhynchus* sp. (larvae) | 0 | 1 | 0 | 0 | 1 |

**Table 3.** Parasitological indexes in ornamental fish species of aquarium shops from Macapá, Amapá State, Brazil. P: Prevalence, MI: Mean intensity, MA: mean abundance, SD: Standard deviation.

| Host species | *Xiphophorus maculatus* | | | *Corydoras ephippifer* | | | *Danio rerio* | | | *Paracheirodon axelrodi* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Parasites species** | **P (%)** | **MI** | **MA ± SD** | **P (%)** | **MI** | **MA ± SD** | **P (%)** | **MI** | **MA ± SD** | **P (%)** | **MI** | **MA ± SD** |
| *Ichthyophthirius multifiliis* | 3.3 | 41.0 | 1.4 ± 7.5 | 0 | 0 | 0 | 0 | 0 | 0 | 13.0 | 83.3 | 11.1 ± 39.9 |
| Monogenea gen. sp. | 3.3 | 3.0 | 0.1 ± 0.5 | 0 | 0 | 0 | 3.3 | 1.0 | 0.03 ± 0.18 | 0 | 0 | 0 |
| Encysted metacercariae | 0 | 0 | 0 | 0 | 0 | 0 | 3.3 | 1.0 | 0.03 ± 0.18 | 6.7 | 3.5 | 0.2 ± 1.0 |
| Diplostomidae (metacercariae) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16.7 | 3.0 | 0.87 ± 2.7 |
| *Acanthostomum* sp. (metacercariae) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.3 | 1.0 | 0.07 ± 0.3 |
| *Camallanus* spp. (larvae) | 3.3 | 1.0 | 0.03 ± 0.2 | 6.7 | 1.0 | 0.07 ± 0.25 | 23.3 | 2.7 | 0.63 ± 1.56 | 3.3 | 1.0 | 0.03 ± 0.2 |
| *Bothriocephalus acheilognathi* | 3.3 | 1.0 | 0.03 ± 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Echinorhynchus* sp. (larvae) | 0 | 0 | 0 | 3.3 | 1.0 | 0.03 ± 0.18 | 0 | 0 | 0 | 0 | 0 | 0 |

in results can be attributed to diverse factors. In general, the presence and transmission of parasites in fish is closely linked to environmental (PIAZZA et al., 2006; GARCIA et al., 2009; MOYSES et al., 2015) and non-environment factors. Water quality parameters in this study had a low variation, thus influencing the reduced appearance of ectoparasite species, which occur mainly in farmed ornamental fish (PIAZZA et al., 2006; GARCIA et al., 2009; KOYUNCU, 2009; MOYSES et al., 2015). The particular characteristics of ornamental fish (e.g. age, physiology, geographic distribution, and feeding habits) are also aspects that may affect the community structure of parasites. These characteristics can make certain potential hosts more susceptible to colonization by new parasites.

The presence and abundance of parasites in ornamental fish species have been mentioned in several studies and parasitism is common and caused by several factors (PIAZZA et al., 2006; KOYUNCU, 2009; TAVARES-DIAS et al., 2010; ABIDI et al., 2011; MOYSES et al., 2015). In this study, 22.5% of the hosts examined were parasitized and the prevalence was similar to that reported (34.0%) for aquarium fish from Florianópolis, Santa Catarina State (PIAZZA et al., 2006). However, the prevalence was lower than that (64.1%) described for 8 species of ornamental fish captured from the Rio Negro river, Amazonas state (TAVARES-DIAS et al., 2010) and *P. axelrodi* (65.2%), which were examined on arrival at the export center in Manaus, Amazonas state (TAVARES-DIAS et al., 2009). Farmed ornamental fish, *Xiphophorus* spp. had a high parasitism level and was infected by *I. multifiliis*, *Trichodina* sp., *Urocleidoides* sp.; and this occurrence was most probably due to inadequate handling and culture practices. There was also a correlation between the intensity of ectoparasites and the parameters of pH, temperature, and electric conductivity of aquarium water (GARCIA et al., 2009). However, in the ornamental fish of this study, the regular use of therapeutic drugs and the moderate levels of salinity found in the aquariums as well as frequent chemotherapy treatments influenced the low levels of ectoparasites found in examined hosts.

*Ichthyophthirius multifiliis*, which is a protozoan parasite with the greatest worldwide distribution, occurred only in *X. maculatus* and *P. axelrodi*, but the infection was one of the lowest levels of fish examined. Infection levels by *I. multifiliis* were similar to those described by Piazza et al. (2006), for this same host. Monogenean infections were observed only in *D. rerio* and *X. maculatus*, which had similar levels of parasitism, and were similar to levels reported for *X. maculatus* found in aquariums from Florianópolis (PIAZZA et al., 2006). However, infection levels by monogeneans in *D. rerio* and *X. maculatus* of this study were lower than those found for other farmed and wild ornamental fish species (PIAZZA et al., 2006; TAVARES-DIAS et al., 2009; 2010). This lower value is most probably due to the uses of chemotherapeutics products in the aquariums of the shops herein investigated.

Species digeneans parasites require an intermediate host to complete its life cycle. Snail species are the primary intermediate hosts of these helminths and fish species are the secondary intermediate hosts, while fish-eating birds are the definite hosts (BULLARD & OVERSTREET, 2008; CARVALHO et al., 2012). Only two species of hosts in this study had digeneans, *P. axelrodi* which was infected by encysted metacercariae, undetermined metacercariae of Diplostomidae and *Acanthostomum* sp., and *D. rerio* which was infected by encysted metacercariae at the lowest level of infection. In Brazil, several species of diplostomids are known in fish, but only two species of *Acanthostomum* Loss are known to infect fish - *Acanthostomum gnerii* Szidat, 1954 and *Acanthostomum spiniceps* Loss, 1899 (KOHN et al., 2007).

*Camallanus* Railliet & Henry, 1915 (Camallanidae) was found in all hosts examined in this study and had similar levels of infection to those of other studies. Only *D. rerio* showed higher levels of infection for this nematode. For *X. maculatus*, levels of infections by *C. maculatus* were similar to those of Piazza et al. (2006). In contrast, *P. axelrodi* had infection levels by *Camallanus* spp. which were lower than those of *Procamallanus* sp. described by Tavares-Dias et al. (2009), for this same fish that was maintained in a holding facility of an exporter in Manaus, Amazonas state. In Brazil, ornamental fish have been infected by a non-native nematode *Camallanus cotti* Fujita, 1927, which infected *Poecilia reticulata* Peters, 1859 (ALVES et al., 2000). Native nematodes such as *Camallanus maculatus* Martins, Garcia, Piazza & Ghiraldelli, 2007 was described infecting *X. maculatus* (MARTINS et al., 2007), *Camallanus acaudatus* Ferraz & Thatcher, 1990 infecting *Osteoglossum bicirrhosum* Cuvier, 1829, and *Camallanus tridentatus* Drasche, 1884 infecting *Arapaima gigas* Schinz, 1822 (FERRAZ & THATCHER, 1990). Few species of *Camallanus* are known to inhabit South America (FERRAZ &

THATCHER, 1990). However, in this study it was not possible to determinate the species of *Camallanus* due to the low abundance level of these endoparasites. The life cycle of the Brazilian *Camallanus* species is unknown, but these typically utilize species of copepod for intermediate host and fish as definitive hosts (DE, 1999; ALVES et al., 2000; MARTINS et al., 2007). Therefore, the presence of infected copepods by camallanids in the aquarium shops may be the cause of the presence of these nematodes in hosts. This study is the first report of presence of *Camallanus* for *P. axelrodi*, *C. ephippifer* and *Danio rerio*.

*Bothriocephalus acheilognathi* Yamaguti, 1934, a cestode Bothriocephalidea which is originated in Asia and has infected fish on every continent due to the translocation of cyprinids fish. This cestode was found infecting *X. maculatus* at low infection levels similar to those levels reported by Piazza et al. (2006) for undetermined cestodes in *X. maculatus*, *Xiphophorus helleri* Heckel, 1848 and *Puntius conchonius* Hamilton, 1822 in aquariums from Florianópolis, SC. This species of cestode has been considered as an endemic threat and known to cause severe damage in small fish at high infection levels. This cestode has no specificity for hosts; thus, it infects more than 200 fish species around the world (MARCOGLIESE & ESCH, 1989; BEAN et al., 2007; SALGADO-MALDONADO et al., 2015). Therefore, this Bothriocephalidea clearly has the potential to regulate fish populations. *Bothriocephalus acheilognathi* utilizes several species of copepods cyclopoids as intermediate hosts, as well as fish, amphibians, reptiles, and birds around the world which could become definitive hosts in potential (MARCOGLIESE & ESCH, 1989; BEAN et al., 2007; SALGADO-MALDONADO et al., 2015). In South America, *B. acheilognathi* was introduced in Brazil for the first time through *Cyprinus carpio* in the 90s. The first record of this non-native cestode was found in *C. carpio* farmed in the Paraná state, southern Brazil (REGO et al., 1999; SALGADO-MALDONADO et al., 2015). Therefore, this study is the second record of *B. acheilognathi* in fish in Brazil, and the first reporting for *X. maculatus*.

In Brazil, over 60 species of acanthocephalans have been described in freshwater fish, including ornamental fish (LUQUE et al., 2017). Acanthocephalans of genus *Echinorhynchus* Zoega in Müller, 1776 was found only in the intestine of *C. ephippifer* at low infection levels. However, infection levels of *Echinorhynchus* spp. were lower than *Quadrigyrus nickoli* reported for *Hyphessobrycon eques*, an ornamental fish from Chumucuí River, Pará state (FUJIMOTO et al., 2013). The complex life cycle of *Echinorhynchus* spp. in freshwater has generally utilized a microcrustacean species as its primary intermediate hosts, and fish as a secondary or definitive hosts (SCHMIDT, 1985; WAYLAND et al., 2015).

As diseases may cause severe morbidity and mortality, which can lead to economic losses in ornamental fish industry, prophylactic treatments should be used when the disease status and the infection source are known (FLORINDO et al., 2017). However, in general, a diagnostic workup of a subsample of the fish is the better method for identifying the problem. In addition, quarantine closely coupled with prophylactic management; the conditioning of ornamental fish during 14-21 days avoids many problems, but generally, this procedure is not practiced. Therefore, quarantine must be a constant procedure in the rearing of aquarium ornamental fish. A major consideration in maintaining an ornamental fish facility is the disinfection and decontamination of the tanks, aquariums and filters, as well as the whole system. Disinfection protocols can be effective if sufficient investments are made in nets, buckets, and other implements which allow adequate exposure time to disinfectants and well as the extensive rinsing of the tools.

In summary, different native and non-native ornamental fish species were found in aquarium shops from the Macapá (AP). Sanitary conditions observed in the aquarium shops were satisfactory in the reduction of the ectoparasites levels and this was due to the constant prophylactic measures used and the good water quality parameters. However, there was a greater diversity of endoparasites, indicating the presence of infective forms originating in the places of production and/or the fish storage facilities. This demonstrates that the quarantine procedures were not very adequate. Thus, we suggest the need of an adequate quarantine system to minimize spreading of these parasites through commercialization of the fish ornamental. There is a worldwide interest in ornamental fish, and although this has led to development of culture techniques, ornamental fish pathogens are spreading very rapidly due to the high monetary benefits of this trade and the growth of the industry. Failure of prophylactic procedures within any link in the productive chain of ornamental fish can create a native parasite transmission risk as well as the risk of infecting non-native ornamental fish. Therefore, concern about parasitic diseases in ornamental fish is increasing, because breaches in proper biosecurity measures could lead to rapid spread of pathogens.

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