Research Article

Metazoan parasites of freshwater ornamental fishes

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ABSTRACT. This study aimed to characterize the metazoan parasitic fauna associated with freshwater farmed ornamental fish in Southern Brazil. Between July 2014 and January 2015, a total of 423 fish belonging to nine species were examined: *Pterophylum scalare*, *Betta splendens*, two varieties of *Carassius auratus*, *Danio rerio*, *Xiphophorus helleri*, two varieties of *Xiphophorus maculatus*, *Poecilia sphenops*, *Tanichthys albonubes* and *Puntius sachsii*. In each fish collection, the water quality parameters were measured. Specimens were obtained from three ornamental fish farms located in three micro-regions in the State of Santa Catarina (Araquari, Biguaçu and Camboriú). Parasitological indexes were obtained after qualitative and quantitative parasitological analysis. Monogenean parasites, nematodes, and cestodes were found in all facilities. Nevertheless, nematodes and monogeneans presented 100% of prevalence in *P. scalare* from Araquari. From the analyzed species, *P. scalare* showed the highest parasite richness.

Keywords: ornamental fish, epidemiology, parasitology, diseases, environment, risk factors.

INTRODUCTION

Parasitic diseases in farmed fish may be caused by agents from different zoological groups. The metazoans are important parasites of ornamental fishes, including monogeneans, digenean trematodes, cestodes, nematodes, and acanthocephalans (NIOF, 2001). These helminths may cause irritation, injury or atrophy of tissues and occlusions of the alimentary canal and may deprive fish of normal feeding. However, the intensity of infection depends on the parasite morphology, size, number, and mode of attachment (Pavanelli *et al*., 2013).

Generally, these parasitic infections/infestations are related to poor health management, which contributes to the deterioration of the water quality. Monogeneans are important parasites found mostly in the gills, fins, and mucus of the body surface. Diseases caused by monogeneans are among the most important for fish farming, and massive mortalities have been observed in farmed fish due to high rates of infestation by these parasites (Portz *et al.,* 2013). Cestodes (Heins *et al*., 2014) and nematodes (Martins *et al*., 2004; Santos & Moravec, 2009) can also cause mortality in farmed fishes due to tissue injury and damage to intestinal functions.

Among the metazoan parasites, *Dactylogyrus extensus* Mueller & Van Cleave, 1932 and *D. anchoratus* (Dujardin, 1845) were reported with 18.4% prevalence in *Carassius auratus* Linnaeus, 1758 (Dove & Ernst, 1998). *Gyrodactylus turnbulli* Harris, 1986 was registered in *Poecilia reticulata* (Peters, 1859) with 91% of prevalence (Thilakaratne *et al*., 2003). In Pakistan, *D. extensus* and *Gyrodactylus* sp. Nordmann, 1832 were registered in *C. auratus* with 63% and 46% prevalence, respectively (Iqbal & Hussain, 2013). Additionally, *D. intermedius* (Weger, 1910), *D. vastator* (Nybelin, 1924), *D. formosus* Kulwiec, 1927 and *D. baueri* Gussev, 1955 were registered in *C. auratus* (Borisov, 2013). The presence of the nematodes

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Capillaria pterophylli (Moravec *et al*., 1987) and *Capillaria ancistri* (Moravec *et al*., 1987) was observed in *Pterophyllum scalare* (Lichtenstein, 1823) (Moravec *et al*., 1987). In São Paulo, Martins *et al*. (2007) identified the parasite *Camallanus maculatus* n. sp. in *Xiphophorus maculatus* (Gunther, 1866). Previous studies have also shown metacercariae of the digenean *Ascocotyle* sp. (Piazza *et al*., 2006) and cystacanths of the acantocephalan *Quadrigyrus nickoli* Schmidt & Hugghins, 1973 parasitizing ornamental fish (Fujimoto *et al*., 2013). More recently, Santos *et al.* (2017) observed monogenean *Diaphorocleidus kabatai* (Molnar, Hanek & Fernando, 1974) Jogunoori, Kritsky & Venkatanarasaiah, 2004 in the gills of *Gymnocorymbus ternetzi*, *D. extensus* Mueller & Van Cleave, 1932, and *D. minutus* Kulwiec, 1927 parasitizing Koi carp. Additionaly, these authors also observed metacercariae of the digeneans in th muscle of *Hyphessobrycon eques*, nematodes of the genus *Rhabdochona* in intestine of *G. ternetzi* and *Bothriocephalus acheilognathi* Yamaguti, 1934 in the intestine of Koi carp.

The assessment of parasitic fauna and parasitological indexes in ornamental fish is important in order to develop appropriate prophylactic techniques, ensuring the production of fish with adequate health conditions and suitability to market requirements. This study aimed to evaluate the parasitic fauna from ornamental freshwater fishes farmed in southern Brazil, considering the possible influence of the handling routine of each facility.

MATERIALS AND METHODS

A total of 423 ornamental fish specimens were collected, between July 2014 and January 2015, from three facilities in the State of Santa Catarina, southern Brazil: fish farm Camboriú (27°1'33"S, 48°39'18"W), fish farm Araquari (26°22'13"S, 48°43'24"W), fish farm Biguaçu (27°29'41"S, 48°39'22"W). The handling characteristics from each facility were registered (Table 1). The following species were collected in fish farm Camboriú: *Carassius auratus* (telescope goldfish, 5.10 ± 2.71 g, 6.09 ± 1.57 mm, n = 29), *C. auratus* (comet goldfish, 5.87 ± 2.84 g, 8.57 ± 1.28 cm, n = 30), *Pterophyllum scalare* Ahl, 1923 (angelfish, 1.73 ± 0.94 g, 4.61 ± 0.82 cm, n = 30). In fish farm Araquari, *P. scalare* (angelfish, 4.67 ± 1.15 g, 6.42 ± 0.47 cm, n = 4), *Poecilia sphenops* Valenciennes, 1846 (black molly 2.43 ± 1.71 g, 5.37 ± 1.42 cm, n = 15), *Xiphophorus helleri* Heckel, 1848 (blood red swordtail 4.0 ± 2.86 g, 6.71 ± 1.15 cm, n = 30), *X. maculatus* Gunther, 1866 (caramel platyfish 2.0 ± 0.57 g, 4.62 ± 0.0 cm, n = 30), *X. maculatus* (wagtail platyfish 1.0 ± 0.43 g, 4.0 ± 0.38 cm, n = 30) were collected. In fish farm Biguaçu, *Betta splendens* Regan, 1910 (siamese fighting fish 0.58 ± 0.79 g, 3.64 ± 1.94 cm, n = 19), *C. auratus* (comet goldfish 3.89 ± 0.89 g, 6.95 ± 0.90 cm, n = 29), *Danio rerio* Hamilton, 1822 (zebrafish 0.55 ± 0.21 g, 3.87 ± 0.71 cm, n = 30), *P. sphenops* (0.89 ± 0.47 g, 4.04 ± 0.59 cm, n = 29), *Puntius sachsii* Ahl, 1923 (goldfinned barb 3.22 ± 1.37 g, 6.16 ± 0.96 cm, n = 30), *Tanichthys albonubes* Lin, 1932 (white cloud mountain minnow 0.48 ± 0.12 g, 3.84 ± 0.33 cm, n = 29), *X. helleri* (2.67 ± 1.93 g, 5.89 ± 1.39 cm, n = 29), *X. maculatus* (wagtail platyfish 1.40 ± 0.63 g, 4.32 ± 0.55 cm, n = 29) were collected.

The water quality parameters were assessed in every fish sampling. The measurement of pH, dissolved oxygen and temperature was performed with a multiparameter HI9146 (Hanna Instruments®, Padova, Italy) and total ammonia was measured with a colorimetric kit (Alfakit®, Florianópolis, Brazil). In fish farm Camboriú, pH was 6.29 ± 1.02; dissolved oxygen 6.57 ± 1.26 mg L^{-1}, temperature 20.65 ± 3.10ºC and total ammonia 0.63 ± 0.35 mg L^{-1}. In fish farm Araquari, pH was 7.10 ± 0.84; dissolved oxygen 5.78 ± 2.36 mg L^{-1}; temperature 23.30 ± 6.04ºC; ammonia 1.16 ± 0.99 mg L^{-1}. In fish farm Biguaçu, pH was 5.93 ± 0.39; dissolved oxygen 4.14 ± 1.77; temperature 21.15 ± 3.73ºC and total ammonia 0.69 ± 1.90 mg L^{-1}.

The fish were transported alive in plastic bags to AQUOS Laboratory for parasitological analysis. They were anesthetized with clove oil (75 mg L^{-1}) and euthanized by a cerebral concussion. These procedures were previously approved by the Ethics Committee for Animal Use of Federal University of Santa Catarina (CEUA/UFSC N°PP00928). After euthanasia, samples of mucus, gills and internal organs were examined according to Eiras *et al*. (2006).

The parasitological indexes were calculated according to Bush *et al.* (1997). Relative dominance was calculated as suggested by Rohde *et al.* (1995). Helminths were processed according to Eiras *et al.* (2006). Briefly, monogeneans were mounted in Hoyer's medium to observe the sclerotized reproductive structures and identified according to Kritsky *et al*. (1986); García-Vásquez *et al*. (2007); Borisov (2013), and. Cestodes were stained with Gomori trichrome, clarified with beechwood creosote and posteriorly mounted between a slide and a coverslip, for the purpose of identification according to Kosuthová *et al*. (2015). The nematodes were processed with regressive staining method and clarified with acetic acid for later analysis and measurements in the light microscope and identified according to Moravec (1987).

Table 1. Management characteristics of ornamental fish farms in Brazil. CP: crude protein.

Characteristics	Fish farm Camboriú	Fish farm Araquari	Fish farm Biguaçu
System and site of culture	Semi-intensive system, earthen pond, water recirculation system	Semi-intensive system, Geomembrane liner	Semi-intensive system; earthen pond with floating cages
Employee management	Aeration, fertilization and liming with crops	Aeration, fertilization and liming with no periodicity	Aeration, fertilization and liming between each fish culture
Feeding	Extruded diet 50% CP	Extruded diet 55% CP	Extruded diet 50% CP
Stocking density	30 fish m^3	No control	No control
Water source	Waterfall	River	Source with interference from rivers
Water quality monitoring	No	No	No
Type of marketing	Middlemen and retailers	Held only for projects	Middlemen and retailers and wholesale

The parasitological indexes were submitted to Mann-Whitney's U test, using Statistica 13.0 (Statsoft Inc., Tulsa, USA), for comparison among the facilities for each species. A non-parametric test was adopted because the values of normality and homoscedasticity did not allow the use of a parametric test.

RESULTS

Most of the examined fishes were not parasitized. The metazoans identified in this study were monogeneans, cestodes, and nematodes. Monogenean parasites were found on the body and gill of the fish species examined, except for *Xiphophorus hellerii*, *Puntius sachsii*, and *Tanichthys albonubes* from fish farms Araquari and Biguaçu. The highest prevalence rate found in the examined fish was monogenean *Gussevia spiralocirra* (Kohn & Paperna, 1964) in the gills of *P. scalare* from fish farm Araquari. This same monogenean species parasitized the gills of *B. splendens* from fish farm Biguaçu. *Gyrodactylus* sp., *Dactylogyrus intermedius*, *D. baueri*, *D. formosus*, *D. anchoratus* was related in gills and body surface mucus of *C. auratus* from fish farm Camboriú. Unidentified species of monogenea were observed parasitizing at low prevalences (Table 2).

The cestode *Bothriocephalus acheilognathi* (Yamaguti, 1934) was also found in intestine of the only in three species of fish from two fish farms, with *X. maculatus* (wagtail platyfish) from fish farm Araquari being the most parasitized fish (6.6%, mean intensity 3.5 ± 3.5), *B. splendens* from fish farm Biguaçu (5.3%, mean intensity 3.0 ± 4.2) and *X. maculatus* (caramel platyfish) from fish farm Araquari (3.3%, mean intensity 1.5 ± 2.1) (Table 3).

In the intestine of *P. scalare* from fish farm Araquari was found nematode at a prevalence of 100% and mean intensity of 9.0 ± 6.3. On the other hand, low prevalences (3.3%) were reported in *X. maculatus* (wagtail platyfish) from fish farm Araquari and *P. scalare* from fish farm Camboriú (Table 3). The greatest richness of parasites was found in *P. scalare* from fish farm Araquari (1.0) (Table 2).

DISCUSSION

According to Blas (2008), the size of the sample is one of the critical factors in characterizing the epidemiological fauna of a population, and the ideal sample size depends on the confidence level and dimension of the population. Sample sizes of 150, 60, and 30 fishes are frequently used, corresponding respectively to 10, 5, and 2% of minimum prevalence with a confidence interval of 95%. Fish that presented n = 30 corresponded to a minimum prevalence of 2%.

Regarding ornamental fish, the monogeneans *D. extensus* and *D. anchoratus* have been reported in goldfish *C. auratus*; *G. turnbulli* in *P. reticulata* (Thilakaratne *et al.*, 2003); *Gyrodactylus* sp. and *Dactylogyrus* spp. in *C. auratus* (Chanda *et al*., 2011); and *D. intermedius*, *D. vastator, D. formosus*, and *D. baueri* in *C. auratus* (Borisov, 2013), corroborating the present findings.

Iqbal & Hussain (2013) have reported a prevalence of up to 86% of monogeneans, different from that observed in *C. auratus* from fish farm Camboriú. High monogenean prevalence can also be explained by other factors such as environmental factors, seasonality, fish behavior, and handling management in farmed fish. Nevertheless, stress caused by variations in the aquatic parameters are the main causes of parasitic infections (Alves *et al*., 2001) besides the host susceptibility and social hierarchy associated with this fish species (Gómez-La-Plaza & Morgan, 2003). The higher prevalence and mean intensities of parasitism by monogenea occurred in fishes from farm Araquari, where the concentrations of ammonia in the water were higher than in the other farms. This is probably due to the use of a feed with a higher amount of crude protein (Table 1), which can result in increased excretion of nitrogenous compounds in the water. The high availa-

Table 2 Parasitological indices of ornamental fish parasitized by Monogenea. Prevalence (P%), mean intensity (MI±standard deviation), mean abundance (MA±standard deviation), relative dominance (RD), richness of parasites (R) and infestation/infection site (SI), gills (G), body surface mucus (M). SD: Standard deviation.

Parasites		Monogenea					
Fish farms	Species \ Indices	SI	*P*	MI	MA	RD	R
Camboriú	*C. auratus* (comet goldfish)	G	26.6	6.1 ± 8.7	3.3 ± 4.6	0.43	0.08
		M	43.3	27.9 ± 39.5	24.2 ± 34.2	0.68	
	C.auratus (telescope goldfish)	G	27.5	19.6 ± 27.7	10.4 ± 14.8	0.81	0.09
		M	24.1	16.4 ± 23.1	7.6 ± 10.8	1	
	P. scalare (angelfish)	G	3.3	1.5 ± 2.1	0.1 ± 0.1	0.0	0.18
		M	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	
Araquari	*P. scalare* (angelfish)	G	100	2,189.7 ± 1,500.5	2,189.7 ± 1,500.5	0.97	1.0
		M	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	
	P. sphenops (black molly)	G	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	0.0
		M	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	
	X. maculatus (caramel platyfish)	G	6.6	3.0 ± 4.2	0.4 ± 0.5	0.52	0.0
		M	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	
	X. maculatus (wagtail platyfish)	G	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	0.06
		M	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	
	X. helleri (blood red swordtail)	G	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	0.10
		M	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	
Biguaçu	*B. splendens* (siamese fighting fish)	G	31.6	0.5 ± 0.7	0.2 ± 0.2	0.46	0.42
		M	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	
	C. auratus (comet goldfish)	G	10.3	1.8 ± 2.5	0.3 ± 0.5	0.48	0.37
		M	24.1	8.6 ± 8.0	3.1 ± 4.2	0.04	
	D. rerio (zebrafish)	G	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	0.03
		M	3.3	0.5 ± 0.7	0.03 ± 0.04	0.01	
	P. sphenops (black molly)	G	3.4	0.5 ± 0.7	0.03 ± 0.05	0.02	0.03
		M	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	
	P. sachsii (goldfinned barb)	G	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	0.0
		M	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	
	T. albonubes (white cloud mountain minnow)	G	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	0.0
		M	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	
	X. helleri (blood red swordtail)	G	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	0.0
		M	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	
	X. maculatus (wagtail platyfish)	GM	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	0.0
			0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	

bility of certain nutrients in the water can promote the proliferation of monogenean parasites (Smallbone *et al.*, 2016). The low prevalence and mean intensities of monogeneans in *X. maculatus* from the same farm may be because monogenean parasites usually present high host specificity (Takemoto *et al.*, 2013). Regarding this result, we can assume that the monogenean species found in high amounts in this farm have a stronger preference for angelfish (*P. scalare*) than for platyfish (*X. maculatus*). This may be also due to the higher sensitivity of angelfish, regarding environmental parameters (Froese & Pauly, 2015).

Bothriocephalus aceilognathi Yamaguti, 1934 are cestodes that affect mainly cyprinid fishes (family Cyprinidae), but can also be found parasitizing fishes from the families Poecilidae, Cichlidae, and Centrarchidae (Scholz, 1997). Kosuthová *et al.* (2015) registered *B. aceilognathi* for the first time in the intestine of *Symphysodon discus* (Heckel, 1940) from Asia at a mean intensity of 30 worms per fish and 80% mortality. In *C. auratus* and *Cyprinus carpio* (Linnaeus, 1758), *B. aceilognathi* was observed at low prevalence, 7%, and 13%, respectively (Dove & Fletcher, 2000). Poecilid ornamental fishes imported into Australia were parasitized by *B. aceilognathi* at a prevalence of 10% to 36% (Evans & Lester, 2001). In this study, this cestode was reported in two varieties of *X. maculatus* from fish farm Araquari, and in *B. splendens* from fish farm Biguaçu, with a higher prevalence than in those examined by Piazza *et al.* (2006). Fish farm Araquari and Biguaçu is a facility where the fish have direct access to sediment (Table 1), allowing the ingestion of

Table 3. Parasitological indices of ornamental fish parasitized by Cestoda and Nematoda. Prevalence (P%), mean intensity (MI ± SD), mean abundance (MA ± SD), mean relative dominance (RD), infestation/infection site (SI), Intestine (I). SD: Standard deviation.

Parasites			Cestoda				Nematoda			
Fish farms	Species \ Indices	SI	*P*	MI	MA	RD	*P*	MI	MA	RD
Camboriú	*C. auratus* (comet goldfish)	I	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0
	C.auratus (telescope goldfish)	I	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0
	P. scalare (angelfish)	I	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	3.3	4.0 ± 5.6	0.2 ± 0.3	0.68
Araquari	*P. scalare* (angelfish)	I	0.0	0.0	0.0	0.00	100	9.0 ± 6.9	9.0 ± 6.9	0.02
	P. shenops	I	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0
	X. maculatus (caramel platyfish)	I	3.3	1.5 ± 2.1	0.1 ± 0.1	0.13	0.0	0.0 ± 0.0	0.0 ± 0.0	0.00
	X. maculatus (wagtail platyfish)	I	6.6	3.5 ± 3.5	0.2 ± 0.2	0.04	3.3	0.5 ± 0.7	0.03 ± 0.04	0.00
	X. helleri (blood red swordtail	I	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0
Biguaçu	*B. splendens* (siamese fighting fish)	I	5.3	3.0 ± 4.2	0.2 ± 0.2	0.46	5.3	0.5 ± 0.7	0.03 ± 0.04	0.07
	C. auratus (comet goldfish)	I	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0
	D. rerio (zebrafish)	I	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0
	P. sphenops (black molly)	I	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0
	P. sachsii (goldfinned barb)	I	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0
	T. albonubes (white cloud mountain minnow)	I	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0
	X. helleri (blood red swordtail)	I	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0
	X. maculatus (wagtail platyfish)	I	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0	0.0	0.0 ± 0.0	0.0 ± 0.0	0.0

benthic copepods that may serve as intermediate hosts of *B. acheilognathi* (Marcogliese & Esch, 1989). This may explain the higher prevalence and intensity of parasitism by this cestode in *P. scalare* from fish farm Camboriú. In contrast, goldfishes (*C. auratus*) from this same farm were not parasitized by *B. aceilognathii*, which may be due to differences in feeding habits between these fish species. The importance of this parasitosis must be emphasized, as the presence of the worm in the intestine may impair digestive functions and inhibit fish growth, causing economic losses (Dove & Fletcher, 2000; Evans & Lester, 2001; Košuthová *et al.*, 2015).

Nematodes were present in 100% of *P. scalare* examined from fish farm Araquari. They are common parasites found in fish, in both larval and adult stages (Martins *et al*., 2007). In ornamental fish, they may cause little damage to the host (Portz *et al*., 2013). However, Santos *et al.* (2017) observed no lesions associated with nematode parasitism in intestine *G. ternetzi*, possibly due to the low degree of infection and mode of attachment of nematodes of genus *Rhabdochona*. In Brazil, *Camallanus cotti* (Fujita, 1927) possibly introduced with the importation of ornamental fishes from Asia has been reported parasitizing poecilids. This is the second reference to the parasite in Brazil and the first report of pathological findings related to this nematode species (Alves *et al*., 2000; Menezes *et al*., 2006). Piazza *et al.* (2006) have reported camallanid nematodes in low prevalence in commercialized *X. maculatus* and *Poecilia sphenops* from Southern Brazil. In *Paracheirodon axelrodi* Schultz, 1956 from an exporter situated in the region of Manaus, state of Amazonas, Northern Brazil, a 23.6% prevalence of *Procamallanus* sp. was recorded (Tavares-Dias *et al*., 2009). Regarding the present study, *Capillaria* sp. was mostly found in *P. scalare*. Nematodes from this genus can spread from one fish to another by ingestion of infective eggs. Furthermore, a recent study showed that *P. scalare* may also serve as an intermediate host for these nematodes (Adel *et al.*, 2013), which may explain the higher prevalence and intensity of parasitism compared with *X. maculatus* from the same farm.

According to Poulin (1995), parasite richness is an important parameter used in population ecology studies. In this study, *P. scalare* was the most parasitized fish species, presenting the highest richness when compared with another species. In fact, this can be explained by the fact that this species is sensitive to changes in environmental quality, especially in temperature, which can directly influence fish physiology, predisposing it to parasitic infections (Froese & Pauly, 2015). In this study, cestodes, nematodes, and monogeneans were found in this species. Monogeneans were found in all analyzed fish farms. However, the fishes from fish farm Camboriú presented higher diversity compared with other fish farms. The highest prevalence was 100%, caused by nematodes and Monogenea in *P. scalare* (Tables 2-3).

This assessment provides useful data for implementation of adequate prophylactic measures to prevent losses caused by parasitism in ornamental fish farming. The knowledge of parasitic fauna allows the adoption of management practices appropriate to the particularities of each species, regarding their susceptibility to certain groups of parasites. In general, it is extremely important to establish a routine of assessment and control of environmental quality in fish farming, respecting the requirements of cultivated fishes, in order to produce better physiological conditions in fish and avoid an excessive proliferation of parasitic populations. These ornamental species are widely traded. They require specific care in culture because it is essential to produce healthy fish with competitive features for the market.

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