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# ORIGINAL ARTICLE / ARTÍCULO ORIGINAL

## INFECTION BY HELMINTHES IN *MYLOSSOMA DURIVENTRE* CUVIER, 1817, A CHARACID FROM THE CENTRAL AMAZON, BRAZIL

## INFECCIÓN POR HELMINTOS EN *MYLOSSOMA DURIVENTRE* CUVIER, 1817, UN CHARÁCIDO DE LA AMAZONÍA CENTRAL, BRASIL

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## Abstract

This study describes the parasitic fauna of *Mylossoma duriventre* caught at Lake Coari, a tributary of the middle Solimões River, in the state of Amazonas (central Amazon, Brazil) and the relative condition factor (Kn). Out of 70 necropsied specimens, 90% had the gills parasitized by the helminth *Anacanthorus paraspathulatus* Kritsky, Boeger & Van Every, 1992 (Dactylogyridae: Anacanthorinae) and the intestine by *Eustrongylides* Jägerskiöld 1909 (Nematoda: Dioctophymatidae) larvae. A total of 19,763 specimens of *A. paraspathulatus* were collected, but the infection by *Eustrongylides* sp. larvae seemed to be accidental, after all, only three hosts were trophically infected. However, there was no significant difference ($p<0.05$) in the Kn of parasitized and non-parasitized fish, indicating that the intensity these parasites not affected the health of host. This is the first report on parasitic infection rates for *M. duriventre*, as well on infections by *Eustrongylides* sp. for this host.

**Key words**: Freshwater fish – Monogenoidea – Nematoda – Parasites.

## Resumen

Este estudio describe la fauna parasitaria de *Mylossoma duriventre* colectada en el Lago Coari, afluente medio del Río Solimões, estado del Amazonas (Amazonía Central, Brasil) y el factor de condición relativo (Kn). De los 70 especímenes necropsiados, 90% estaban con las branquias parasitadas por el helminto *Anacanthorus paraspathulatus* Kritsky, Boeger & Van Every, 1992 (Dactylogyridae: Anacanthorinae) y el intestino por larvas de *Eustrongylides* sp. Jägerskiöld, 1909 (Nematoda: Dioctophymatidae). Fueron colectados 19 763 especímenes de *A. paraspathulatus,* pero la infección por larvas de *Eustrongylides* sp. parece accidental, debido a que solamente tres hospederos fueron infectados por vía trófica. Sin embargo, no hubo diferencia significativa ($p<0,05$) en el Kn de peces parasitados y no parasitados, indicando que la intensidad de parásitos no afecta la salud del hospedero. Este es el primer registro sobre tasas de infección parasitaria para *M. duriventre* y de infección por *Eustrongylides* sp.

**Palabras clave**: Monogenoidea - Nematoda - Parásitos - Peces de agua dulce.

## INTRODUCTION

The Solimões-Amazonas basin is a typical large river system with large adjacent plains that are influenced by a predictable hydrological cycle with annual flooding resulting from a lateral overflow of water from the main channel of the river towards the plain. At the peak of the flood, much of the area is inundated and almost all the lakes become connected with each other and with the river. In this ecosystem, there are different species of fish widely adapted with different strategies and lifestyles. In lakes, *Mylossoma duriventre* Cuvier, 1817 (Characidae) adults are caught in open water and in flooded forest, while juveniles are caught only in the flooded forest (Soares *et al*., 2007).

The *M. duriventre* is distributed throughout the Amazon Basin, its main nutrient-rich tributaries and also in the Tocantins and Araguaia rivers (Araújo-Lima & Rufino, 2003). A pelagic fish with omnivorous feeding habits, *M. duriventre* shows ontogenetic variations in its diet. Adults feed mainly on leaves, fruit and seeds from the flooded lowland forests and small terrestrial and aquatic invertebrates (Claro-Júnior *et al*., 2004, Soares *et al*., 2007). Juveniles show a preference for grass and small mollusks. This fish is diurnal and migratory, thus, during the period of ebb tide, it migrates upstream to spawn in the confluence of rivers. It has total spawning and external fertilization. Females begin the sexual maturation process with 15.5 cm and males with 14.8 cm. Its reproduction period is long, covering periods of drought (November) and flood (May), with a more intense spawning between the months of December and February (Soares *et al*., 2007).

This characid is medium sized, reaching up to 25 cm of total length and 500 g of weight. It is greatly appreciated by the riverside population and also by the urban population, therefore its has great importance in extractive fishery and it is one of the main species sold at fairs and markets of the Amazon (Soares *et al.*, 2007). In 2007, the production of the extractive fishery of *Mylossoma* spp. was 6543.0 tons, which generated US$ 16.358 millions for the local economy (Ibama, 2007). Thus, *M. duriventre* is undoubtedly an economically important specie for the Amazon region (Araújo-Lima & Rufino, 2003). So, the health and parasites of this characid fish should be studied.

Condition factor is an important tool for the study of fish welfare reflecting directly on its health. Analysis of variations in this indicator has been used to evaluate the effects of different parasites on hosts populations or individuals (Guidelli *et al*., 2011; Silva *et al*., 2011a,b). Some parasites seem not to exert negatives effects on their hosts, while others can have deleterious effects in the health of the hosts (Silva *et al*., 2011b).

For *M. duriventre*, literature reports the occurrence of acanthocephalan *Echinorhynchus salobrensis* Machado, 1948 in fish from Mato Grosso (Machado-Filho, 1948), monogenoideans *Anacanthorus paraspathulatus* Kritsky, Boeger & Van Every, 1992 in fish from the Lake Janauacá in the State of Amazonas (Kritsky *et al*., 1992) and larvae of nematodes *Goezia* sp. and *Spectatus* sp. in fish from the Paraná River (Moravec, 1998). Nevertheless, there are no studies on the parasitic rates for this Amazonian freshwater fish.

Since most parasites have a complex lifecycle involving intermediate and definitive hosts, they can be indicators of changes in the environment and also in the fish community (Takemoto *et al*., 2009; Guideli *et al.,* 2011; Silva *et al*., 2011b). Therefore, it is relevant to known the strategies in the parasite-host relationship in wild populations of fish (Takemoto *et al*., 2009; Sloboda *et al*., 2010; Silva *et al*., 2011b), so such knowledge may later be used in aquaculture. Parasitism can influence wild fish populations either directly through mortality events or indirectly by reducing the fecundity, altering the hosts' behavior or increasing the risk of predation (Longshaw *et al*., 2010; Takemoto & Lizama, 2010). Werder & Sant-Paul (1979) have stated that *Mylossoma* spp. has farming potential. Thus, taking into consideration the size of the Amazon fish fauna, it is evident that there is still a lot to be studied regarding parasites of wild populations of fish, including *M. duriventre*.

The present work studied the parasitic fauna of *M. duriventre* from Lake Coari, in middle Solimões River basin, State of Amazonas (central Amazon) as well as the relative condition factor (Kn).

## MATERIALS AND METHODS

**Fish and collection**

*Mylossoma duriventre* specimens were collected in the flooded forest of Lake Coari (04º04' 072"S, 063°10'004"W), a tributary of the Solimões River, in the municipality of Coari (State of Amazonas) for parasitological studies. All fish were collected with appropriate different nets (ICMBIO: 11884-1).

**Parasitological examination**

All fish were weighted (g), measured for total length (cm) and necropsied in accordance with ethical procedures for the presence of parasites. Detailed macroscopic evaluation of the body surface, mouth, eyes, gills and opercula were held for each specimen. The gills were removed, placed in slides with 0.8 % NaCl solution and analyzed with an ordinary light microscope. Organs were removed for parasitological examination of the gastro intestinal tract, placed in Petri dishes containing 0.65% NaCl solution and examined in stereomicroscope. The methodology used for collection, fixation (Eiras *et al*., 2006; Thatcher, 2006) and quantification (Tavares-Dias *et al*., 2001) were those recommended in literature. The identification of parasites followed the recommendations from Kritsky *et al.* (1992), Moravec (1998), Thatcher (2006) and Luque *et al.* (2011). Ecological terms were according to Bush *et al.* (1997).

**Host-parasite relationship**

After the determination of the body weight and the total length of each fish, the relative condition factor (Kn) was calculated according to Le-Cren (1951). Differences in the Kn of parasitized and non-parasitized fish were compared by *t* test ($p<0.05$). Spearman correlation coefficient ($r_s$) was used to determine possible correlations between the intensity of parasites and the total length and weight of the host fish (Zar, 1999).

**Physico-chemical parameters of the water**

The concentration of dissolved oxygen and the temperature were determined with a digital oximeter. The water temperature ranged from 29.6 to 31.1 ºC and the dissolved oxygen ranged from 4.5 to 6.3 mg/L.

## RESULTS

Fish had the gills parasitized by monogenoidean *Anacanthorus paraspathulatus* (Dactylogyridae, Anacanthorinae) and the intestine by *Eustrongylides* Jägerskiöld, 1909 (Nematoda: Dioctophymatidae) larvae. However, dominance was of *A. paraspathulatus* (Table 1).

There was no difference between the Kn of parasitized and non - parasitized by monogenoideans and nematodes (Table 2).

In *Mylossoma duriventre* there was no correlation between the intensity of *A. paraspathulatus* and the weight (*rs*= -0.0927, p=0.399), the total length (*rs*=-0.0927, p= 0.472) and the hosts' Kn (*rs*= -0.0090, p=0.944).

**Table 1**. Parasite helminthes in *Mylossoma duriventre* from lake Coari, middle Solimões River, State of Amazonas, central Amazon, Brazil. EF: Examined fish; PF: Parasitized fish; P: Prevalence; MI: Mean intensity; TNP: Total number of parasites; SD: Standard deviation.

| Taxa/Parasites | EF/PF | P (%) | MI ± SD | TNP | Range |
|---|---|---|---|---|---|
| **Monogenoidea** | | | | | |
| *Anacanthorus paraspathulatus* | 70/63 | 90.0 | 316.0 ± 113.6 | 19.763 | 86-691 |
| **Nematoda** | | | | | |
| *Eustrongylides* sp. (Larvae) | 70/3 | 4.3 | 0.19 ± 0.4 | 3 | 1 |

**Table 2**. Biometric parameters and relative condition factor (Kn) of *Mylossoma duriventre* from lake Coari, middle Solimões River, state of Amazonas, central Amazon, Brazil. Values in parenthesis indicate the range. Different letter in same line indicates differences by the *t test*.

| Parameters | Non-parasitized (N=7) | Parasitized (N=63) | *p* |
|---|---|---|---|
| Weight (g) | 188.6 ± 45.8a | 213.0 ± 42.4a | 0.290 |
| | (120.0-250.0) | (42.4-120.0) | - |
| Length (cm) | 19.2 ± 1.6a | 20.0 ± 1.5a | 0.434 |
| | (16.5-19.0) | (17.0-23.0) | - |
| Kn | 1.000 ± 0.010a | 1.000 ± 0.023a | 0.938 |
| | (0.988 1.020) | (0.934 1.069) | - |

## DISCUSSION

This study reports a parasitic fauna in wild *M. duriventre* constituted by one species from monogenoidean specie and one species from nematode. Contrastingly, other studies reported a larger parasitic fauna in *Aphyocharax anisitsi* Eigenmann & Kennedy, 1903, *Psellogrammus kennedyi* Eigenmann, 1903, *Astyanax altiparanae* Garutti & Britski, 2000 , *Metynnis lippincottianus* Cope, 1870, *Piaractus mesopotamicus* Holmberg, 1887, *Serrasalmus marginatus* Valenciennes, 1837, *Serrasalmus maculatus* Kner, 1858 and *Salminus brasiliensis* Cuvier 1816; all characid species from the upper Paraná river (Takemoto *et al.*, 2009), as well as in *Oxydoras niger* Valenciennes, 1821 from the Lake Coari (Silva *et al.*, 2011). However, the parasitic fauna of freshwater fish may vary depending on the host's species, the level occupied by the host in the food chain, its age and sex, besides other biotic and abiotic factors (Takemoto & Lizama, 2010; Silva *et al.*, 2011b).

Monogenoideans are parasites with direct lifecycles which are usually host specific (Thatcher, 2006; Takemoto *et al*., 2009; Takemoto & Lizama, 2010). About 308 species of Monogenoidea from 70 genera have been described parasitizing 144 fish species in Amazon and Neotropical zone, with an average of 2.14 parasites by host. Therefore, only about 3% of Monogenoidea species are known (Thatcher, 2006), hence the number of species described tends to increase in Amazon. *Anacanthorus* Mizelle & Price 1965 is one from a number of Monogenoidea parasites found infecting the gills of freshwater characid fish species from the Amazon. Sixty-three species of the genus *Anacanthorus* are known as parasites of freshwater Neotropical fish, and of these parasites, sixty-two species are found in fish from the Amazon Basin River. However, only the *A. paraspathulatus* have already been found parasitizing *M. duriventre* (Kritsky *et al*., 1992; Thatcher, 2006).

In the gills of *M. duriventre* from Lake Coari, the prevalence of monogenoidea *A. paraspathulatus* (90%) was higher than that of *Cosmetocleithrum* spp. (70.3%) in *O. niger* (Silva *et al*., 2011a) and *Gyrodactylus gemini* Ferraz, Shinn & Sommerville 1994 (56%) in *Semaprochilodus insignis* Jardine, 1841 (Silva *et al*., 2011b), while the intensity was lower that in *O. niger*. However, the prevalence and the intensity were higher than those described for *Demidospermus* sp. in *Auchenipterus osteomystax* Miranda Ribeiro 1918 from Paraná River (Tavernari *et al*., 2009). Infection rates by monogenoideans may vary depending on the hosts' species, their physiological and immunological status, and on abiotic factors. The infection rates did not influence the well-being of *M. duriventre*, since its relative condition factor (Kn) was not affected by parasitism.

Overdispersed distributions of Nematoda are commonly observed within host fish populations and are important for understanding many density-

dependent processes in host–parasite interactions. The proximate causes of such distributions are poorly understood, especially in natural systems, but heterogeneity among hosts in the exposure to infective parasite stages is thought to be an important factor. Parasites transmitted by prey fish serving as intermediate hosts and variability in feeding behavior among fish predators within host populations may have a strong influence on parasite distributions (Moravec, 1998; Martins *et al*., 2009). However, omnivorous fish such as *M. duriventre* (Araújo-Lima & Rufino, 2003; Soares *et al.*, 2007) show lower risks of parasitism because they are primary consumers occupying lower trophic levels in the food chain (Martins *et al*., 2009; Silva *et al*., 2011).

The nematode *Eustrongylides* larvae commonly infect fish-eating aquatic birds as their definitive host. They have oligochaetes as their first intermediate host and fish as their second intermediate host or paratenic (Mitchel *et al*., 2009; Sloboda *et al*., 2010). They may infect different organs of freshwater fish from all over the world, from America to Asia. Piscivorous predator fishes can have seasonal infection due to increased feeding activity in summer and autumn (Martins *et al*., 2009). In Brazil, *Eustrongylides* larvae occur in many freshwater fish species from different families (Martins *et al*., 2009; Takemoto *et al*., 2009; Luque *et al*., 2011), except *M. duriventre*. However, only larvae of *Eustrongylides ignotus* Jägerskiöld, 1909 (Takemoto *et al*., 2009; Luque *et al*., 2011) and *Eustrongylides tubifex* Nitzsch, in Rudophi, 1819 (Luque *et al*., 2011) have been identified in fish. These endohelminths fish parasites are of interest due to their pathogenicity for the hosts (Mitchell *et al*., 2009) and their zoonotic potential for humans (Barros *et al*., 2006; Barros *et al*., 2009; Martins *et al*., 2009). In fish, infection by *Eustrongylides* larvae may increase their predation susceptibility, infected host fish exhibit erratic movements when compared to non-infected ones (Sloboda *et al*., 2010).

In *M. duriventre* from Lake Coari (in central Amazon), levels of infection by *Eustrongylides* sp. were low and smaller than those of *Pseudoplatystoma fasciatum* Linnaeus, 1766 (Barros *et al*., 2006; Barros *et al*., 2009), *Brycon hilarii* Valenciennes, 1850, *Pseudoplatystoma corruscans* Spix & Agassiz, 1829, *Pinirampus pirinampu* Spix & Agassiz, 1829 and *Zungaro zungaro* (Humboldt, 1821) from Cuiabá river, in the State of Mato Grosso (Barros *et al*., 2006) and of *Cichla piquiti* Kullander & Ferreira, 2006, *Hoplias malabaricus* Bloch, 1794 and *Plagioscion squamosissimus* Heckel, 1840 from Paraná River, in the state of São Paulo (Martins *et al*., 2009). However, they were similar to those described for *S. marginatus*, but they did not occur in *M. duriventre* from Cuiabá River (Barros *et al*., 2006).

Nevertheless, the distribution, intensity and prevalence of *Eustrongylides* sp. may be strongly influenced by the environment and the host's general conditions (Martins *et al*., 2009; Mitchel *et al*., 2009), as well as by dense populations of oligochaetes, the natural intermediate hosts of this nematode parasite of wild fish. In addition, some fish species may be only the transporters (paratenic hosts) of this nematode or have an accidental infection, as it seems to have occurred with *M. duriventre* from Lake Coari, which were adult fish. Adults *M. duriventre* besides leaves, also consume fruit and seeds from the Amazonian flooded forest and small terrestrial and aquatic invertebrates (Claro-Júnior *et al*., 2004, Soares *et al*., 2007). However, this omnivorous characid is a pelagic fish which have almost no contact with oligochaetes, the first intermediate host of the *Eustrongylides* larvae.

In conclusion, the characid *M. duriventre* is a fish species that migrates a few hundred km for its reproduction (Araújo-Lima & Rufino, 2003; Soares *et al*., 2007); hence this host presented a reduced parasitic fauna in the flooded forest ("igapó") from Lake Coari which was constituted basically by monogenoideans parasites. However, the low presence of *Eustrongylides* larvae seems to be due to a lack of contact with first intermediate hosts in the environment.

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