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LARVAL DIVERSITY OF PLEROCERCOIDS (EUCESTODA: TETRAPHYLLIDEA) IN *TRICHIURUS LEPTURUS* LINNAEUS, 1758 (PERCIFORMES: TRICHIURIDAE) FROM THE COAST OF RIO DE JANEIRO STATE, BRAZIL

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ABSTRACT

The life cycle of tetraphyllid cestodes is complex, involving a diversity of plerocercoid larvae that can utilize teleost fish as a second intermediate host or paratenic host. The objective of this study is the morphological characterization of tetraphyllid plerocercoids in *Trichiurus lepturus* Linnaeus, 1758 from the coast of the state of Rio de Janeiro, Brazil. In July 2018, 33 specimens of *T. lepturus* were obtained from commercial fishermen, captured near the Cagarras archipelago (23°1'52"S, 43°11'56"W), state of Rio de Janeiro, Brazil. The hosts were weighed, measured, and subjected to necropsies under a stereoscopic microscope for the collection of plerocercoids. The collected specimens were fixed and prepared following traditional helminthological techniques. Morphological and morphometric studies of the parasites were conducted, considering the size, body shape, and characteristics of the scolex and bothridia. Four morphotypes of plerocercoids were identified: Morphotype I corresponds to the genus *Phoreiobothrium* Linton, 1889, Morphotype II to *Triloculatum*

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Caira & Jensen, 2009, and Morphotype IV to the genus *Anthobothrium* van Beneden, 1850. Morphotype III belongs to *Rhinebothrium* Linton, 1889, *Caulobothrium* Baer, 1849, or *Rhabdotobothrium* Euzet, 1953. The morphological richness of plerocercoids in *T. lepturus* indicates the ecological importance of this host for the life cycle of tetraphyllids on the coast of the state of Rio de Janeiro. An identification key for the plerocercoid morphotypes of *T. lepturus* was also included.

Keywords: ichthyoparasitology – cestode larvae – morphology – neotropical – large head hairtail

RESUMO

O ciclo de vida dos cestóides tetrafilídeos é complexo, com larvas plerocercóides podendo utilizar peixes teleósteos como segundo hospedeiro intermediário ou hospedeiro paratênico, nos quais podem apresentar uma diversidade de larvas plerocercóides. O objetivo do presente trabalho é a caracterização morfológica dos plerocercoides de tetrafilídeos em *Trichiurus lepturus* Linnaeus, 1758 do litoral do estado do Rio de Janeiro, Brasil. Em julho de 2018, 33 espécimes de *T. lepturus* foram adquiridos de pescadores profissionais, pescados nas proximidades do arquipélago das Cagarras (23°1'52"S, 43º11'56"O), estado do Rio de Janeiro, Brasil. Os hospedeiros foram pesados, medidos e as necrópsias foram realizadas em microscópio estereoscópio para a coleta dos plerocercóides. Os espécimes coletados foram fixados e preparados de acordo com técnicas helmintológicas tradicionais. Os estudos morfológicos e morfométricos dos parasitos foram realizados considerando o tamanaho, formato do corpo e características do escólex e dos botrídios. Quatro morfotipos de plerocercóides foram verificados: Morfotipo I corresponde ao gênero *Phoreiobothrium* Linton, 1889, o Morfotipo II, a *Triloculatum* Caira & Jensen, 2009, e o Morfotipo IV ao gênero *Anthobothrium* van Beneden, 1850. O Morfotipo III pertence a *Rhinebothrium* Linton, 1889, *Caulobothrium* Baer, 1849 ou *Rhabdotobothrium* Euzet, 1953. A riqueza morfológica de plerocercóides em *T. lepturus*, aponta a importância ecológica desse hospedeiro para o ciclo de vida dos tetrafilídeos do litoral do estado do Rio de Janeiro. Também foi proposta uma chave de identificação, para os morfotipos de plerocercóides de *T. lepturus*.

Palavras-chave: ictioparasitologia – larvas de cestóides – morfologia – neotropical – peixe espada

RESUMEN

El ciclo de vida de los cestodos tetrafílidos es complejo, con larvas plerocercoides que pueden utilizar peces teleósteos como segundo hospedador intermediario u hospedador paraténico, en los cuales pueden presentar una diversidad de larvas plerocercoides. El objetivo de este trabajo es la caracterización morfológica de los plerocercoides de tetrafílidos en *Trichiurus lepturus* Linnaeus, 1758 de la costa del estado de Río de Janeiro, Brasil. En julio de 2018, se adquirieron 33 especímenes de *T. lepturus* de pescadores profesionales, capturados cerca del archipiélago de Cagarras (23°1'52"S, 43º11'56"O), estado de Río de Janeiro, Brasil. Los hospedadores fueron pesados, medidos y se realizaron necropsias con microscopio estereoscópico para la recolección de los plerocercoides. Los especímenes recolectados fueron fijados y preparados siguiendo técnicas helmintológicas tradicionales. Los estudios morfológicos y morfométricos de los parásitos se realizaron considerando el tamaño, la forma del cuerpo y las características del escólex y los botridios. Se identificaron cuatro morfotipos de plerocercoides: el Morfotipo I corresponde al género *Phoreiobothrium* Linton, 1889, el Morfotipo II a *Triloculatum* Caira & Jensen, 2009, y el Morfotipo IV al género *Anthobothrium* van Beneden, 1850. El Morfotipo III pertenece a *Rhinebothrium* Linton, 1889, *Caulobothrium* Baer, 1849 o *Rhabdotobothrium* Euzet, 1953. La riqueza morfológica de los plerocercoides en *T. lepturus* señala la importancia ecológica de este hospedador para el ciclo de vida de los tetrafílidos en la costa del estado de Río de Janeiro. También se incluyó una clave de identificación para los morfotipos de plerocercoides de *T. lepturus.*

Palabras clave: ictioparasitología – larvas de cestodos – morfología – neotropical – pez espada

INTRODUCTION

Tetraphyllidean plerocercoids (Cestoda: Eucestoda) have a cosmopolitan distribution; show marked host specificity and coevolutionary patterns, besides being the most diversified and frequent group of helminths parasitizing elasmobranchs (Heywood, 1995; Poulin & Morand, 2000; Caira & Jensen, 2001; Suriano, 2002; Randhawa & Poulin, 2009; Kleinertz *et al.*, 2022; Bueno & Caira, 2023). They develop an indirect life cycle composed of three hosts: procercoid stage, in copepods (first intermediate host), plerocercoid in teleosts, marine mammals and cephalopods (second intermediate or paratenic host) and adults in elasmobranchs (= definitive hosts) (Williams & Jones, 1994; Muñoz & Cribb, 2006; Aznar *et al.*, 2007; Jensen & Bullard, 2010; Caira *et al.*, 2020). Adults are usually found associated with the spiral valve of the elasmobranch´s intestine whereas plerocercoids can be found at several sites of infection such as liver, body cavity, and mesentery (Chambers *et al.*, 2000). Plerocercoids may migrate through the organs and cause macro and microscopic splanchnic anomalies including reduction in reproductive capacity and survival of the host (Ehab & Faisal, 2008) or if plerocercoids are present in muscles, they damage the skeleton system, and when they are present in gonadal tissue, they damage the reproductive system (Imran *et al.*, 2021).

The life cycles of marine Tetraphyllidean, especially those of sharks and rays, are little known due to the difficulty to identify early scoleces as they differ from those in adults (Chambers *et al.*, 2000; Jensen, 2005; Caira & Reyda, 2005; Jensen & Bullard, 2010; Bueno & Caira, 2023).Thus, Müller (1787) named the genus *Scolex* to accommodate the gastro-intestinal plerocercoids of Teleostei with apical sucker surrounded by four acetabula, divided or not, under the name *S. pleuronectis* Müller, 1788. Later on, Rudolphi in 1819, questioned the validity of these species, synonymizing them as *S. polymorphus* Rudolphi, 1819 (Chambers *et al.*, 2000). Given the multiplicity of verified morphotypes was found that the names *S. pleuronectis* and *S. polymorphus* are collective that include plerocercoids sharing characteristics common to Tetraphyllidean (Wardle & Mcleod, 1952; Caira & Ruhnke, 1991; Dick & Choudhury, 1995; Jensen & Bullard, 2010; Maghrabi & Gharabawi, 2011; Alves *et al.*, 2017). In attempt to solve this question, Chambers *et al.* (2000) performed the morphological identification and *in vitro* culture of plerocercoids from Australia which allowed them to verify morphological changes in the larvae and the proposal of 11 different morphotypes. None of the morphotypes reached maturity through *in vitro* cultivation.

In a research work done by Muñoz & Cribb (2006) with *Coris batuensis* (Bleeker, 1857) collected in the vicinity of Lizard Island, Australia, was represented by eight morphotypes of plerocercoids, four of which are similar to those described by Chambers *et al.* (2000) and another four were suggested as new morphotypes. In this study, each morphotype was considered as a species since they are clearly different from each other. Choudhury & Scholz (2020) and Nazarizadeh *et al.* (2022) on the other hand, carried out the molecular identification of plerocercoids in *Bothriocephalus cuspidatus* Cooper, 1917 and *Ligula intestinalis* (Linnaeus, 1758).

A large sampling effort was carried out in the Gulf of Mexico, in which were collected 25 species of adult cestode from sharks and rays, 27 species of cestode larvae in fish, bivalves, gastropods and crustaceans, comprising 75 species of three phyla, 14 orders and 46 families. Morphological and molecular biology data were obtained from larvae and adults therefore identifying 15 plerocercoids morphotypes and dichotomous key proposal including the morphotypes of Chambers *et al.* (2000) for the identification of these larvae (Jensen & Bullard, 2010).

In Brazil, several research works have registered the occurrence of *S. pleuronectis*, *S. polymorphus* or *Scolex* sp. in teleosts (Rêgo & Santos, 1983; Rêgo *et al.*,1983; Takemoto *et al.*, 1996a, 1996b; Knoff *et al.*, 1997; Palm, 1997; Luque *et al.*, 2000, 2008; Luque & Alves, 2001; Paraguassu *et al.*, 2002; Alves *et al.*, 2002a, 2002b, 2003, 2004; Tavares *et al.*, 2004; Alves & Luque, 2006; Felizardo *et al.*, 2010; Carvalho & Luque, 2011, Bueno *et al.*, 2014; Alves *et al.*, 2017; França, 2019). Silva *et al.* (2000), Carvalho & Luque (2011), and França (2019) recorded plerocercoids parasitizing *Trichiurus lepturus* Linnaeus, 1758 collected along the shore of the state of Rio de Janeiro.

Trichiurus lepturus Linnaeus, 1758 (Scombriformes, Trichiuridae) known as cutlassfish, is a cosmopolitan species distributed between latitudes 60° N and 45° S. In the Atlantic Ocean, the species is distributed from the United States of America (40° N), to Argentina (37° S), from the coastline to depths of 350 meters (Magro, 2006; Froese & Pauly, 2023). As for the behavior, they are benthopelagic, with a predominantly piscivorous diet, but with high food plasticity (Chiou *et al.*, 2006; Bitar *et al.*, 2008; Froese & Pauly, 2023).

This study characterizes morphologically the Tetraphyllidean plerocercoids from largehead hairtail, *T. lepturus* in the shore of the state of Rio de Janeiro, Brazil.

MATERIAL AND METHODS

In July 2018, thirty-three specimens of *T. lepturus*, measuring 931.64±74.41cm (700-1.050cm) in length and weighing 589.7±88.18g (400-795g) were obtained from professional fishermen. Fishes were captured in the vicinity of Cagarras archipelago (23°1'52"S, 43º11'56"O), along the shores of the State of Rio de Janeiro, Brazil. Then, they were carried in isothermal containers with ice to the Laboratory of Parasitology of the Instituto Federal de Educação, Ciência e Tecnologia do Sudeste de Minas Gerais – Campus Juiz de Fora for research of plerocercoids. Fish were identified according to Eschmeyer *et al.* (2023).

For recovery procedures, specimens were eviscerated; their organs transferred to individual Petri dishes with a 0.65% NaCl solution to be examined under a stereoscopic microscope. The collected larvae were fixed in cold AFA for 48 h, stained with Mayer's carmine, cleared in beechwood creosote and mounted in Canada balsam (Amato & Amato, 2010).

For the morphological and morphometric studies of the plerocercoids morphotypes, a Nikon E200 optical microscope was used, and it was geared with a drawing tube and micrometer eyepiece. All measurements of length, width of specimens and length and width of apical sucker and bothridia were made, according with Chambers *et al.* (2000). The measured values are provided in micrometers and the amplitude of variation is given in parentheses.

The taxonomic classification of Cestoda was performed according to Khalil *et al.* (1994). For the identification of specimens were used the studies of Chambers *et al.* (2000), Muñoz & Cribb (2006), Felizardo *et al.* (2010) and Jensen & Bullard (2010).

The infrapopulation indicators used were prevalence, mean intensity, and mean abundance, calculated according to Bush *et al.* (1997). They presented the range of infection. The Discrepancy index (*D*), computed using the program Quantitative Parasitology 3.0 (Rózsa *et al.*, 2000), was used to detect distribution patterns of the infrapopulations (Poulin, 1993).

Voucher specimens were deposited in the Helminthological Collection of the Instituto Oswaldo Cruz (CHIOC), Rio de Janeiro, Brazil.

Ethic aspects: All national and institutional guidelines for use of animals were followed. All fishes were purchase died.

RESULTS

In the current study, 251 plerocercoids were recovered from the digestive tract, being 57 specimens of Morphotype I, 65 of Morphotype II, 75 of Morphotype III and 54 of Morphotype IV. Twenty-two (66.7%) hosts were parasitized by at least one plerocercoid morphotype. The mean abundance of plerocercoids in the hosts was 7.6±12.2 (1–50) plerocercoids/fish. Four morphotypes of Tetraphyllidea plerocercoids were identified in *T. lepturus*, as described below:

Morphotype I (CHIOC N° 39787a-c)

(Figure 1a)
Description (six specimens measured): robust and elongated body, 885±78 (750–940) length and 143±11 (130–160) width; scolex without rostellum and four rounded biloculars bothridia, free at the extremities, division between the bothridium *loci* in V format, 75±9 (70–90) length and 65± 5 (60–70) width; apical sucker, 53±8 (40–60) length and 55±5 (50–60) width.

Morphotype II (CHIOC N° 39788a-c)

(Figure 1b)
Description (six specimens measured):thin and elongated body, with posterior narrowing to the scolex, 1.075±145 (975–1.325) length and 150±31 (125–200) width; scolex with rostellum and four biloculars bothridia, with the *loci* divided by a clear septum, giving a semi-lunar shape to the previous loculi, 65±16 (50–90) length and 55±5 (50–60) width; and centralized apical sucker on the rostellum, 58±11 (40–70) length and 65±17 (50–90) width.

Morphotype III (CHIOC N° 39789a-c)

(Plate 1c)
Description (six specimens measured): tapered and robust body, 819±220 (575–1.150) length and 253±46 (180–300) width; inverted scolex, with four pedunculated and multilocular bothridia, divided by a longitudinal septum and several transverse septa, 213±51 (170–300) length and 153±36 (100–200) width; apical sucker was not observed.

Morphotype IV (CHIOC N° 39790a-c)

(Plate 1d)
Description (six specimens measured): robust body with narrowing at the end of scolex, 830±29 (780–850) length and 208±22 (180–240) width; rounded scolex without rostellum, and four unilocular acetabula in form of sucker, 98±15 (80–120) length and 93±15 (70–110) width; and centralized apical sucker, 65±15 (50–90) length and 75±5 (70–80) width.

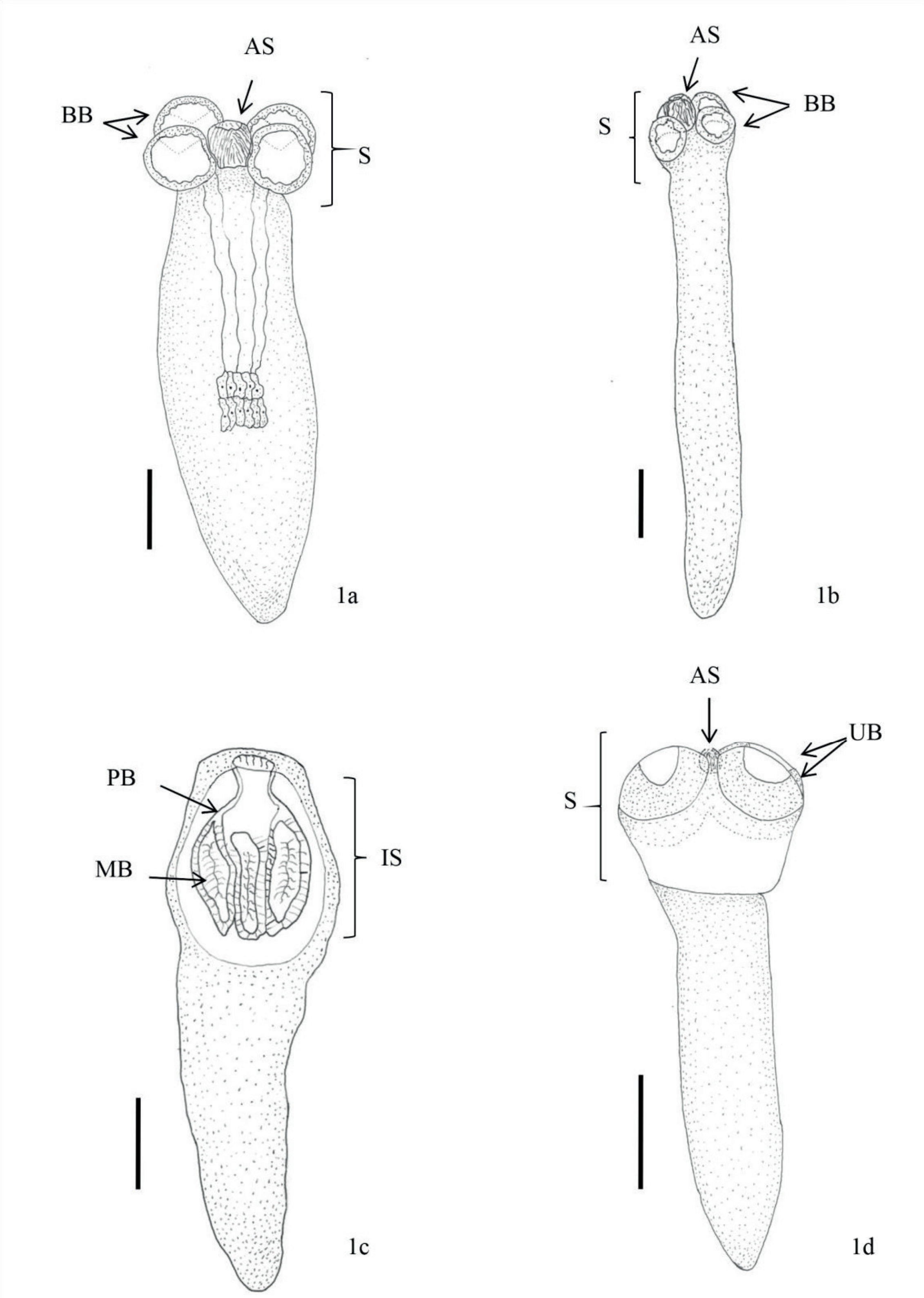

Figure 1. Plerocercoids in *Trichiurus lepturus* Linnaeus, 1758, from the Rio de Janeiro, Brazil: 1a. Morphotype I; 1b. Morphotype II; 1c. Morphotype III; 1d. Morphotype IV. Abbreviations: BB - biloculars bothridia; AS - apical sucker; S – scolex; PB - pedunculated bothridia; IS – inverted scolex; MB - multilocular bothridia; UB - unilocular bothridia. (Scale: 100 μm).

The correspondence between the morphotypes described in the present work and the morphological types described in other studies as well as the differences between them are presented in Table 1.

Table 1. Correspondence and differences of the morphological types of plerocercoids of *Trichiurus lepturus* Linnaeus, 1758 from the coastal zone of the state of Rio de Janeiro, Brazil, with morphotypes registered in other studies.

Current study	Other studies		Divergences from this study
	Name	Authorship	
Morphotype I	Morphotype IV	Chambers *et al.* (2000)	Bilocular bothridia; division into V shaped
	Morphotype B	Muñoz & Cribb (2006)	Bilocular bothridia; division into V shaped
	Group A; Type A1	Jensen & Bullard (2010)	Bothridia smaller in length and wider
Morphotype II	Group A; Type A6	Jensen & Bullard (2010)	Scolex with rostellum; bothridia smaller, divided into two *loci*, the distal being half-moon
Morphotype III	Morphotype V	Chambers *et al.* (2000)	Smaller body; absence of apical sucker
Morphotype IV	Plerocercoid	Felizardo *et al.* (2010)	Absence of apical sucker
	Group G; Type VI; Sub-group G1 and G2	Jensen & Bullard (2010)	Narrowing between the scolex and the body; greater acetabula than the apical sucker
			G1 – Smaller plerocercoids

The infrapopulational descriptors of the morphotypes described in the present work demonstrated to be quite similar. The Morphotype III presented higher prevalence and mean abundance while Morphotype IV was the least prevalent and abundant (Table 2). All morphotypes presented aggregate distribution in the host population demonstrated by the Discrepancy index (*D*) (Table 2).

Table 2. Prevalence, range of infection, mean intensity, mean abundance, discrepancy index and site of infection of the plerocercoids morphotypes parasites of *Trichiurus lepturus* Linnaeus, 1758 from the coastal zone of the state of Rio de Janeiro, Brazil.

Plerocercoids	Prevalence(%)	Range of infection	Mean intensity	Mean abundance	Discrepancy index (D)	Site of infection
Morphotype I	30.3	1-16	5.8±4.83	1.76±3.62	0.802	Intestine
Morphotype II	24.2	1-20	7.38±6.41	1.79±4.26	0.838	Intestine
Morphotype III	33.3	1-15	6.09±4.74	2.03±3.83	0.781	Intestine
Morphotype IV	21.2	3-13	7.71±3.95	1.64±3.54	0.817	Intestine

DISCUSSION

Morphotypes I and II can be accommodated in Group A with type A1 larvae, organized in six subgroups (A1 to A6), as suggested by Jensen & Bullard (2010).The Morphotypes I and II of the study resemble type A1 (Jensen & Bullard, 2010) by the following characteristics: larvae elongate, tapering posteriorly; scolex with apical sucker and four acetabula in form of bothridia, round to oval, sessile or slightly free anteriorly and posteriorly, divided in to anterior and posterior *loci*; bothridia non-retractable, and body undivided. However, morphotype II differs from morphotype I by being longer and presenting bilocular bothridia with a semilunar shape, while in morphotype I the bothridia division is V-shaped in addition to presenting a rostellum.

Morphotype III with bothridia inverted resembles the morphology and morphometry to the Morphotype V, suggested by Chambers *et al.* (2000) and to the plerocercoid described by Felizardo *et al.* (2010). However, it differs from these two morphotypes by the absence of the apical sucker. For Chambers *et al.* (2000), the presence of cryptic species within the types, as evidenced by Morphotype III, may be an indication that the real species richness is underestimated, since in the cultivation of these plerocercoids, the evagination of bothridia revealed the presence of two distinct forms, one form had 48 *loci* per bothridium and another 74 *loci*, indicating the presence of cryptic species within the Type designated by morphological characteristics.

Morphotype IV can be associated with Group G, composed of larvae of the Type VI, organized into two subgroups (G1 and G2), suggested by Jensen & Bullard (2010). The general characteristics presented by morphotype IV and that resemble type VI of Jensen & Bullard (2010) are: larvae elongate, tapering posteriorly; scolex with apical sucker and four acetabula in form of sucker; acetabulum rounded, sessile, undivided, no retractable, and hooks absent, and larval body not divided.

As suggested by Jensen & Bullard (2010), the Morphotype I resembles the Type A1, which, for the authors, represents a subgroup of species of *Phoreiobothrium* Linton, 1889. On the other hand, the Morphotype II of this work resembles the Type A6 suggested by Jensen & Bullard (2010) which by molecular data may belong to *Triloculatum* Caira & Jensen, 2009. The characteristics of Morphotype III are similar to those of *Rhinebothrium* Linton, 1890, *Caulobothrium* Baer, 1948 or *Rhabdotobothrium* Euzet, 1953, once the adult specimens, classified in this family do not present apical sucker. Furthermore, according to Jensen & Bullard (2010), the "Group G" is a subgroup composed of adults representing three species of *Anthobothrium* Van Beneden, 1850 with larvae of the Type VI – G1 and a subgroup composed of adults representing two species of *Anthobothrium*, with larvae of the Type VI – G2 (Jensen & Bullard, 2010). The Morphotype IV of this work resembles the plerocercoids of the Type VI – G1, representing a subgroup belonging to the genus *Anthobothrium*. It is worth mentioning that the larval morphotypes A1, A6 and G1 studied and identified by Jensen & Bullard (2010) were also collected in *T. lepturus*.

To optimize the study and know the real biodiversity of these tetraphillidean larvae that use cutlassfish as an intermediate host, an identification key is suggested for the plerocercoids of *T. lepturus* from Guanabara Bay, Rio de Janeiro:

1a. Bothridia inverted, with four pedunculated and multilocular bothridia, divided by a longitudinal septum and several transverse septa; tapered and robust body, >575µm in total length; apical sucker not observed……………………Morphotype III (e.g. *Rhinebothrium* Linton, 1890, *Caulobothrium* Baer, 1948 or *Rhabdotobothrium* Euzet, 1953)

1b. Bothridia evertide…………………………….….2

2a. Unilocular bothridia; robust body, with narrowing at the end of scolex, >780µm in total length; rounded scolex without rostellum; greater acetabula than the apical sucker……………………................Morphotype IV (e. g. *Anthobothrium* Van Beneden, 1850)

2b. Biloculars bothridia...3

3a. Biloculars bothridia, free at the extremities, division between the bothridium *loci* in "V" format; robust and elongated body, >750µm in total length; greater acetabula than the apical sucker………………………………..….. Morphotype I (e. g. *Phoreiobothrium* Linton, 1890)

3b. Biloculars bothridia, with the *loci* divided by a clear septum, giving a semi-lunar shape to the previous loculi; thin and elongated body, with posterior narrowing to the scolex, >975µm in total length; acetabula with a width similar to that of the apical sucker or slightly larger……………….Morphotype II (e.g. *Triloculatum* Caira & Jensen, 2009)

Teleosts seem to play a prominent role in the life cycle of cestodes, genera *Phoreiobothrium*, *Triloculatum*, and *Anthobothrium* whose adults are found sharks, since the larvae of these three genera were confirmed only in fish (Jensen & Bullard, 2010; Alves *et al.*, 2017; Caira *et al.*, 2020; Bueno & Caira, 2023). In Brazil, studies have proven the occurrence of *T. lepturus* composing the diet of several species of sharks (Vaske-Júnior & Rincón-Filho, 1998; Bornatowski & Schwingel, 2008; Bornatowski *et al.*, 2014) which reinforces the importance of this host species in the marine cestode life cycle.

In relation to population indicators, Morphotypes III and I showed lower prevalence, abundance and intensity of infection than those reported, respectively, by Muñoz & Cribb (2006) and Felizardo *et al.* (2010). According to Chambers *et al.* (2000), these two morphotypes demonstrated low host specificity, once Morphotype I (Type IV) was recorded in 30 species of fish belonging to 12 families and Morphotype III (Type V) in 14 species belonging to seven families. Using a host specificity index, suggested by Caira *et al.* (2003), Jensen & Bullard (2010) concluded that all larvae, except for those of *Rhodobothrium* larvae, exhibited euryxenous host specificity, that is, they infect more than a single host family.

Furthermore, by reinforcing this low specificity characteristic of plerocercoids, *C. batuensis* presented richness composed of eight morphotypes (Muñoz & Cribb, 2006) while *T. lepturus* was one of the species of fish with greater richness of larvae, hosting larvae belonging to six species in five genera, the definitive hosts of most of the species beeing sharks (Jensen & Bullard, 2010).

The aggregate distribution in the host population demonstrated by all the plerocercoid morphotypes described in the present work indicates to be a distribution pattern for vertebrate macroparasites (Poulin, 2007; Morril & Forbes, 2016; Warburton & Vonhof, 2018). This distribution may be caused by differences in host susceptibility to infection, heterogeneity in the ability of hosts to eliminate parasites by immunological response and by individual differences in host food habits (Morril & Forbes, 2016; Warburton & Vonhof, 2018).

The identification of these larval types given the difference between larval and adult scolex, the morphological similarity between larval types of different genera as well as the possible presence of cryptic species within the groups should be confirmed molecularly. Thus, future works with this integrative approach between morphological and molecular characters are extremely important for the knowledge of the real biodiversity of the species of cestode larvae that occur in *T. lepturus* from Brazil. Further work is needed to study the seasonality of these larval types, since Carvalho & Luque (2011) verified variations in the prevalences, abundance and intensity of these larvae between the seasons with peaks in the summer, in *T. lepturus*.

Author contributions: CRediT (Contributor Roles Taxonomy)

ARC = Adriano Reder de Carvalho
SSL = Sueli de Souza Lima
FMV = Fabiano Matos Vieira

Conceptualization: ARC, SSL, FMV
Data curation: ARC
Formal Analysis: ARC, FMV
Funding acquisition: ARC
Investigation: ARC, SSL, FMV
Methodology: ARC, FMV
Project administration: ARC
Resources: ARC
Software: ARC, FMV
Supervision: FMV
Validation: ARC, SSL, FMV
Visualization: ARC, SSL, FMV
Writing – original draft: ARC, SSL, FMV
Writing – review & editing: ARC, FMV

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