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Original Article

Cucullanus marajoara n. sp. (Nematoda: Cucullanidae), a parasite of *Colomesus psittacus* (Osteichthyes: Tetraodontiformes) in the Marajó, Brazil

Cucullanus marajoara n. sp. (Nematoda: Cucullanidae), um parasito de *Colomesus psittacus* (Osteichthyes: Tetraodontiformes) no Marajó, Brasil

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Abstract

Cucullanus marajoara n. sp. (Cucullanidae) is reported to parasitize *Colomesus psittacus* (Tetraodontiformes), which is a fish species from the Marajó Archipelago, state of Pará, estuarine region of the Brazilian Amazon. The new species differs from similar species by the presence of a protruding upper lip on the cloacal opening, the distribution of the cloacal papillae: five pre-cloacal papillae pairs and 5 are ventral and located posteriorly to the pre-cloacal sucker and an unpaired papilla is located on the upper cloacal lip and five post-cloacal pairs, and a pair of lateral phasmids located between papillae pairs. Additionally, *Cucullanus marajoara* n. sp. is compared to other species of this genus described in Brazil, particularly *Cucullanus ageneiosus* and *Cucullanus oswaldocruzi*, which both occur in the same zoogeographic region of this study but parasitize fish of a different order (Siluriformes). *Cucullanus dodsworthi* and *Cucullanus brevicaudatus* are the only described species parasitizing fish of the order Tetradontiformes in Brazil, and the new species differs from these species by the distribution of the cloacal papillae and the host habitat. The description of *Cucullanus marajoara* n. sp. adds data to the biodiversity of described parasites that parasitize Tetradontiformes of the estuarine ichthyofauna in the Brazilian Amazon.

Keywords: Helminth, parasite, nematoda, puffer fish.

Resumo

Cucullanus marajoara n. sp. (Cucullanidae) é descrita parasitando *Colomesus psittacus* (Tetraodontiformes) peixe do arquipélago de Marajó, Estado do Pará, região estuarina da Amazônia brasileira. A nova espécie difere de seus congêneres por apresentar lábio superior da abertura cloacal protrudente e na distribuição de papilas cloacais: 5 pares pré-cloacais, e uma papila não pareada no lábio superior da cloaca e 5 pares pós-cloacais, um par de fasmídeos laterais. Além disso, *Cucullanus marajoara* n. sp. é comparada com outras espécies do gênero descritas no Brasil, em especial *Cucullanus ageneiosus* e *Cucullanus oswaldocruzi*, ambos parasitos de peixes da ordem Siluriformes; porém, ocorrendo na mesma região zoogeográfica deste estudo, diferem da ordem do hospedeiro da nova espécie (Tetraodontiformes). *Cucullanus dodsworthi* e *Cucullanus brevicaudatus* são as únicas espécies descritas parasitando peixe da ordem Tetradontiformes no Brasil, e a nova espécie difere dessas na distribuição das papilas cloacais e habitat dos hospedeiros. *Cucullanus marajoara* n. sp. adiciona dados a biodiversidade de parasitos descritos parasitando Tetradontiformes da ictiofauna estuarina da Amazônia brasileira.

Palavras-chaves: Helminto, parasito, nematoda, baiacu.

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Introduction

The northern estuary of Brazil has a rich ichthyofauna, particularly fish of the order Tetraodontiformes. Among these, the family Tetraodontidae includes four species: *Colomesus psittacus* (Bloch & Schneider, 1801), *Colomesus asellus* (Müller & Troschel, 1849), *Colomesus tocantinensis* Amaral, Brito, Silva & Carvalho (2013), *Sphoeroides testudineus* (Linnaeus, 1758), and *Lagocephalus laevigatus* (Linnaeus, 1766) (KRUMME et al., 2004). *Colomesus psittacus*, popularly known in Brazil as "baiacu" (puffer fish), is a demersal fish of marine-estuarine waters with depths of up to 40 m, although it often is found in freshwater. This species is distributed in the Western Atlantic principally from the Gulf of Paria (Venezuela) in the north to the Amazon River, state of Pará in Brazil (CERVIGON et al., 1992; FROESE & PAULY, 2018) in the south. Baiacu can be found throughout the entire Amazonian estuary (CAMARGO & MAIA, 2008).

The genus *Cucullanus* Müller (1777), contains approximately 100 fish parasite species worldwide (TIMI & LANFRANCHI, 2006; GIESE et al., 2010; LACERDA et al., 2015). Approximately 32 species have been described in the Neotropical region of the American continent (LÓPEZ-CABALLERO et al., 2009; GIESE et al., 2010; LACERDA et al., 2015). The species *Cucullanus genypteri* Sardella, Navone & Timi, 1997, *C. marplatensis* Daniel, Timi & Sardella, 2002, and *C. bonaerensis* Lanfranchi, Timi & Sardella, 2004 were described in South America. *Cucullanus pedroi* was described in Argentina (TIMI & LANFRANCHI, 2006). *Cucullanus colossomi* Díaz-Ungría, 1968, that is a parasite of *Colossoma macropomum*, was found in the Orinoco River, Venezuela, and *Cucullanus bagre* Petter, 1974, that is a parasite of *Bagre bagre*, was described in French Guiana.

For fish from Brazil, Luque et al. (2011) listed *Cucullanus cirratus* Müller, 1777, *Cucullanus pulcherrimus* Barreto, 1918; *Cucullanus dodsworthi* Barreto, 1922; *Cucullanus pinnai* Travasso, Artigas, & Pereira, 1928; *Cucullanus zungaro* Vaz & Pereira, 1934; *Cucullanus pauliceae* Vaz & Pereira, 1934; *Cucullanus schubarti* Travasso, 1947; *Cucullanus mogi* Travassos, 1947; *Cucullanus carioca* Vicente & Fernandes, 1973; *C. rougetae* Vicente & Santos, 1974; *Cucullanus oswaldocruzi* Santo, Vicente & Jardim, 1979; *Cucullanus grandistomis* (Ferraz & Thatcher, 1988); *Cucullanus patoi* Fortes, Hoffmann & Sarmento, 1992; *Cucullanus brevispiculus* Moravec, Konh & Fernandes, 1993; *Cucullanus pimelodellae* Moravec, Kohn & Fernandes, 1993; *Cucullanus fabregasi* Fortes, Hoffmann & Sarmento, 1993; *Cucullanus riograndensis* Fortes, Hoffmann & Sarmento, 1993; *Cucullanus debacoi* Sarmento, Fortes & Hoffmann, 1995; *Cucullanus cassinensis* Pereira Jr. & Costa, 1996; *Cucullanus pinnai pterodorasi* Moravec, Kohn & Fernandes, 1997; *Cucullanus pseudoplatystomae* Moravec, Kohn & Fernandes, 1997; *Cucullanus rhamphichthydis* Moravec, Kohn, and Fernades, 1997; *Cucullanus heliomartinsi* Moreira, Rocha & Costa, 2000; and *Cucullanus ageneiosus* Giese, Furtado, Lanfredi & Santos, 2010. Moravec (1998) considered *C. patoi*, *C. fabregasi*, *C. riograndensis*, and *C. debacoi*, and Timi et al. (2009) considered *C. cassinensis* to be species *inquirenda*.

Pereira et al. (2014) described *Cucullanus brevicaudatus* as a parasite of *Balistes capriscus*, a marine fish collected in Rio de Janeiro state, Brazil. Vieira et al. (2015) described *Cucullanus gastrophysi*, *Cucullanus protrudens*, and *Cucullanus pseudopercis* and redescribed *Cucullanus cirratus*, *Cucullanus pedroi*, and *Cucullanus genypteri* from fish collected from the same state and thus added new data to the biodiversity of Cucullanidae parasites from Brazilian fish fauna. Lacerda et al. (2015) described *Cucullanus tucunarensis* as a parasite of *Cichla piquiti* (Cichliformes) in the Tocantins River and Pereira & Luque (2017) described *Cucullanus opisthoporus* in *Cichla melaniae* in the Xingu River, Pará.

Colomesus psittacus commonly enters the fish traps along the shore, but they are not harvested because they produce a tetradoxina toxic to humans (SANTANA et al., 2010). The fishermen discard the fish outside of the traps. Because they were available abundantly and not part of the local source of food, we decided to investigate the parasite fauna of the species. During this study, a new species of *Cucullanus* was found; it is described herein and compared with other members of the genus recorded from the same zoogeographical region and the same group of hosts (Tetraodontiformes).

Materials and Methods

Twenty specimens of *C. psittacus* were caught by fishermen in the municipality of Soure (0°53'39" S, 48° 7'39" W), Marajó Archipelago, Pará state (Brazil). The fish were obtained from riverine fishermen who discarded them from their catch and were transported on ice to the Laboratório de Histologia e Embriologia Animal, Instituto da Saúde e Produção, Universidade Federal Rural da Amazônia, Campus Belém, Pará state, Brazil. The weight (g) and total length (cm) of the specimens were measured. After biometric analysis, the animals were necropsied to search for helminths. The digestive tract was isolated in petri dishes containing physiological solution and analyzed under a stereomicroscope (Leica – ES2). The collected helminths were fixed in an alcohol-formaldehyde-acetic acid (AFA) solution (930 mL of 70% ethanol, 50 mL of commercial formalin, and 20 mL of glacial acetic acid) stored at room temperature. Subsequently, the specimens were dehydrated in an ethanol series, clarified with Aman's lactophenol, and examined by light field microscopy using a Leica DM2500 microscope with a clear camera for scientific imaging and morphometric analysis.

Ten male specimens and ten female specimens were used for the morphometric analysis of the helminths. The measurements were made in millimeters as the means, with the ranges shown in parentheses. For scanning electron microscopy, the helminth specimens were washed in distilled water, postfixed in 1% osmium tetroxide, dehydrated to the critical point of CO_2, metallized with gold + palladium, and analyzed using a TESCAN scanning electron microscope (VEGA 3) in the Laboratório de Microscópia Eletrônica de Varredura da Universidade Federal Rural da Amazônia. There are more than 100 putative species in the genus, so the suggestions of (YOOYEN et al., 2011; LACERDA et al., 2015), that morphological and morphometric comparisons should be made only among the different species that parasitize the same taxonomic group of hosts from the same zoogeographical region in which the host was found. The host fishes scientific name is in accordance with FishBase (FROESE & PAULY, 2018).

Results

Survey data

Of the 20 specimens of *C. psittacus* collected in the Soure municipality, 90% (18 infected fish/ 20 examined fish) were parasitized by nematodes of the genus *Cucullanus*, which we compared in their morphology and morphometric with other members of the genus recorded for the zoogeographic region and the same group of hosts, and we proposed the species *Cucullanus marajoara* n. sp.

Family Cucullanidae Cobbold 186

Cucullanus marajoara n. sp.

(Based on light microscopy and scanning electron microscopy examination: Figs. 1-3)

Medium-sized nematode, opaque white when alive. Females are larger than males, and the morphology of the anterior region is similar in both genders (Figures 1a and 2a). A thick cuticle forms a lateral cervical flap in some specimens, and the presence of thin transverse striae are observed along the body. The cephalic end is rounded, and an oral aperture in the form of a dorsoventral cleft is surrounded by a cuticular ring and delimited by a row of small teeth (Figures 2a-b). Presence of four external cephalic papillae, four internal papillae, and a pair of dorsolateral amphids (Figures 2a-b). The claviform muscular oesophagus is divided into two distinct and well-developed regions, and a well sclerotized anterior region forming an oral pseudocapsule (oesophastome) with a nerve ring is located in this region (Figure 1a). The posterior region of the oesophagus is expanded and opens into the intestine by a strong valve. The diverticulum of the oesophagus and intestinal cecum are absent. Deirids at level of the middle glandular oesophagus, and the excretory pore is located below the oesophagus (Figures 1a, 2c-d).

Males (Based on 10 specimens, measurements of the holotype in brackets): Body length of 7.59 (6.0–10.6) [8], and maximum width at the junction between the esophagus and bowel of 0.27 (0.19–0.36) [0.29]. Muscular oesophagus with a size of 0.76 (0.63–0.91) [0.77] × 0.13 (0.1–0.2) [0.13]. Oesophastome with a size of 0.28 (0.25–0.33) [0.28] × 0.14 (0.13–0.16) [0.14]; the oesophagus represents 10% (8–13%) [10%] of the total body length. The nerve ring, deirids, and excretory pore are positioned 0.32 (0.22–0.86) [0.26], 0.65 (0.52–0.76) [0.63], and 0.81 (0.65–0.97) [0.78] from the cephalic end, respectively. A muscular precloacal sucker with a diameter of 0.10 (0.08–0.15) [0.097] is located 0.76 (0.61–0.88) [0.84] from the posterior extremity (Figures 1b, c, 3a). The cloacal opening has a protruded upper lip (Figures 1b, 3d). Postdeirids are not observed. Ten pairs of caudal papillae are observed as follows: five precloacal pairs (the first pair is located anteriorly to the cloacal sucker, and pairs No. 2, 3, 4, and 5 are ventral and located posteriorly to the cloacal sucker) and five postcloacal pairs (pairs No. 6, 8, and 10 are ventral, pair No. 7 is lateral, and pair No. 9 is dorsal); a pair of lateral phasmids is located between pairs No. 8 and 10 (Figures 1b-c and 3a- c). Unpaired ventral papilla is located slightly anterior to the cloacal protrusions (Figures 1b-c and 3d). The spicules are long, filiform, subequal, and sclerotized, with a length of 0.78 (0.56-1.00) [0.78], representing 10% (8–12.5%) [9.75%] of the total body length (Figures 1b, c and 3a). The gubernaculum is sclerotized and is

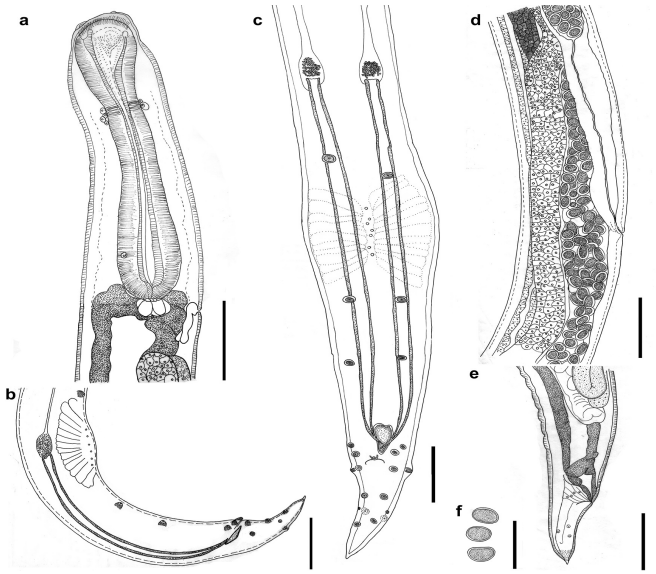

Figure 1. *Cucullanus marajoara* n. sp. a parasite of *Colomesus psittacus* from Soure, Marajó Archipelago, state of Pará, eastern Amazon, Brazil: (**a**) Cephalic region view. Bar = 100 µm; (**b**) Posterior end of male, lateral view. Bar = 100 µm; (**c**) Caudal region of male, ventral view. Bar = 150 µm; (**d**) Vulval region, lateral view. Bar = 100 µm; (**e**) Egg from ovijector. Bar = 100 µm; (**f**) Posterior end of female, lateral view. Bar = 200 µm.

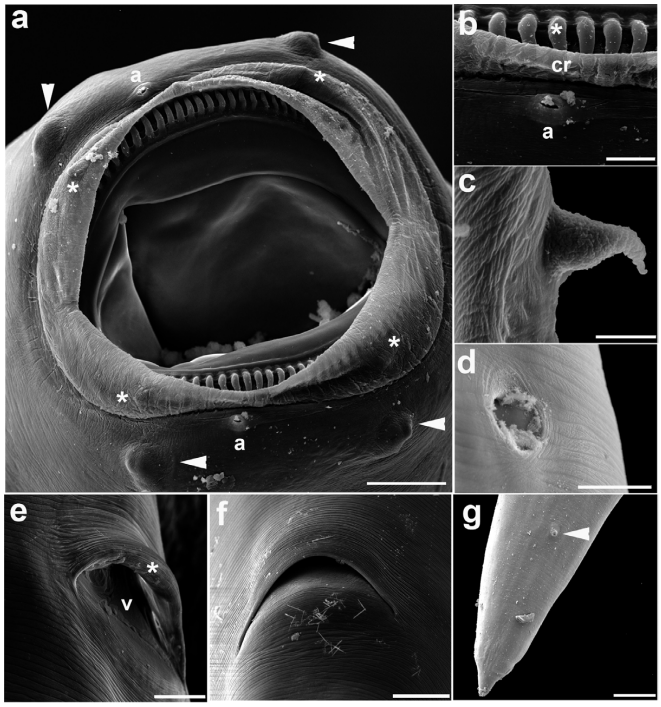

Figure 2. *Cucullanus marajoara* n. sp. of *Colomesus psittacus.* Scanning electron micrographs of a female: (**a**) Cephalic region subapical views, oral aperture with four external papillae (arrowheads), four internal papillae (*), and amphid (a). Bar = 20 µm; (**b**) Detail showing the oral aperture with teeth (*) surrounded by a cuticular ring (cr) and amphid (a). Bar = 5 µm; (**c**) Deirid. Bar = 5µm; (**d**) Excretory pore (ep). Bar = 10 µm; (**e**) Vulval region (v) and protruding upper lip (*) in the lateral view. Bar = 20 µm; (**f**) A anal region, ventral view. Bar = 20 µm; (**g**) Arrowheads indicate phasmids. Bar = 25 µm.

spoon-shaped in the lateral view, with a length of 0.07 (0.06-0.08) [0.08]. The conical tail has a length of 0.22 (0.20-0.26) [0.22]; the caudal alae and cuticular projection are absent (Figures 1c and 3a).

Females (Based on 10 gravid specimens with immature eggs, measurements of allotype in brackets): Body length of 9.5 (7.55–12.12) [12.12], maximum width at the junction between the esophagus and intestine of 0.35 (0.28–0.46) [0.39]. The oesophastome has a size of 0.3 (0.28–0.33) [0.33] × 0.15 (0.13–0.17) [0.17]; the muscular oesophagus has a size of 0.84 (0.76–0.91) [0.91] × 0.15 (0.13–0.18) [0.18], with the oesophagus representing 9% (7–11%) [7.6] of the total body length. The nerve ring, deirids, and excretory pore are located 0.29 (0.26–0.32) [0.3], 0.76 (0.64–0.95) [0.91], and 0.95 (0.78–1.23) [0.94] from the anterior extremity, respectively. Vulva postequatorial is located 5.96 (4.68–7.75) [7.75] from the cephalic end and has a prominent upper lip (Figures 1d and 2e). The eggs have a size of 0.04 (0.03–0.05) × 0.03 (0.03–0.04) (Figures 1d, f). Tail conical has a length of 0.26 (0.23–0.31) [0.25]; the phasmids are conspicuous and lack a cuticular projection at the extremity (Figures 1e, 2g). The anus has a prominent upper lip (Figures 1e, 2f).

Taxonomy Summary:

Cucullanus marajoara n. sp.

Host: *Colomesus psittacus* Bloch and Schneider, 1801 (Tetraodontiformes: Tetraodontidae) – **Common name:** Baiacu (puffer fish)

Average length and weight of hosts: 35.5 cm and 368.5 g, respectively.

Site of infection: Middle intestine.

Biome: Amazon - **Environment**: Estuarine

Location type: Municipality of Soure, Marajó Archipelago, state of Pará, Brazil.

Prevalence: 90% (20 host examined, 18 hosts infected)

Etymology: The specific name *marajoara* refers to the geographical region of the distribution (i.e., Arquipélago de Marajó, state of Pará, Amazon, Brazil).

Deposit of Specimens: Coleção Helmintológica do Instituto Oswaldo Cruz

(acronym CHIOC), State of Rio de Janeiro, Brazil: *Cucullanus marajoara* n. sp. CHIOC 38584 a-h (holotype: 38584a

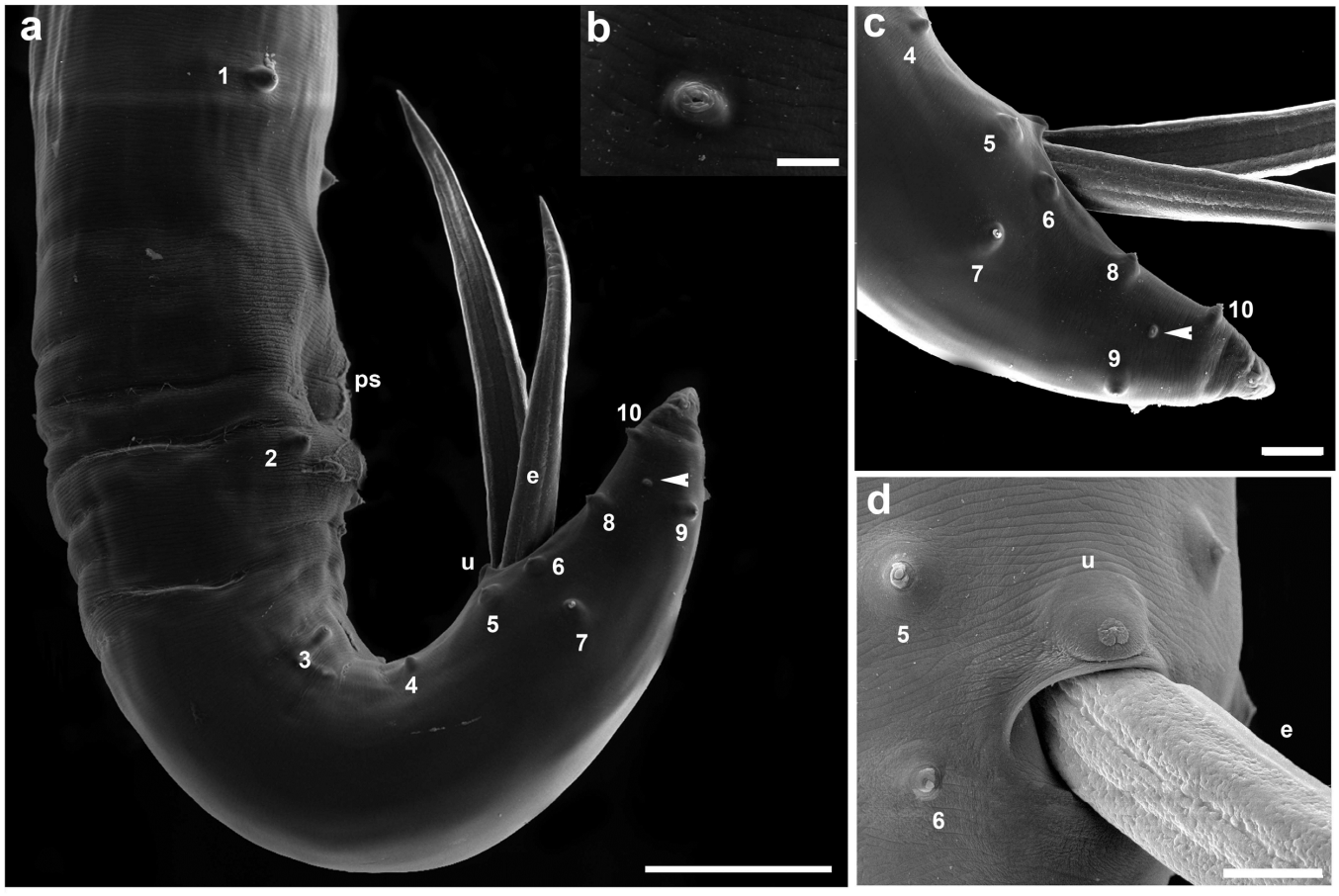

Figure 3. *Cucullanus marajoara* n. sp. of *Colomesus psittacus*. Scanning electron micrographs of a male: (**a**) Tail region, lateral view, caudal papillae, 10 pairs: five pre-cloacal pairs (the first pair is located anterior to the pre-cloacal sucker, whereas pairs No. 2, 3, 4, and 5 are ventral and located posterior to the pre-cloacal sucker) and five post-cloacal pairs (pairs No. 6, 8, and 10 are ventral, pair No. 7 is lateral, and pair No. 9 is dorsal); the pseudosucker (ps) and pair of lateral phasmids are located between pairs No. 8 and 10 and the spicule (e). Bar = 100 µm; (**b**) Detail of phasmids. Bar = 5 µm. (**c**) Detail of the tail showing four pairs of ventral papillae (No. 5, 6, 8, and 10), a lateral pair (No. 7), a dorsal pair (No. 9), and phasmids (arrowheads). Bar = 25 µm; (**d**) Detail of the unpaired papilla (u), spicule (e). Bar = 20 µm.

and allotype: 38584b and paratypes: female 9c; paratypes: male 7d; paratypes: male 8e; paratypes: male 10f; voucher female: g-h).

Discussion

The genus *Cucullanus* contains more 100 nominal species that parasitize freshwater, brackish, and marine fish (LÓPEZ-CABALLERO et al., 2009; YOOYEN et al., 2011; LACERDA et al., 2015). Moravec et al. (1993) was if the opinion that species of *Cucullanus* have a fairly uniform morphology and that some species had been described incorrectly; thus, performing a detailed comparison between all species was impracticable. Therefore, morphological and morphometric comparisons among different species should consider the taxonomic group of the host (MORAVEC et al., 2005; GONZÁLEZ-SOLÍS et al., 2007; LÓPEZ-CABALLERO et al., 2009; YOOYEN et al., 2011; PEREIRA et al., 2015) and the zoogeographical region in which the host was found (MORAVEC et al., 1997; SARDELLA et al., 1997; CASPETA-MANDUJANO et al., 2000; DANIEL et al., 2002; LANFRANCHI et al., 2004; CABAÑAS-CARRANZA & CASPETA-MANDUJANO, 2007; PEREIRA et al., 2015; LACERDA et al., 2015) were selecting species for comparison.

In Brazil, genus *Cucullanus* contains 27 parasite species from 10 different orders of fish (Siluriformes, Perciformes, Cichliformes, Characiformes, Tetradontiformes, Gymnotiformes, Ophidiiformes, Anguilliformes, Lophiiformes, and Gadiformes) that are present in different aquatic environments, including freshwater, estuarine, and marine. The order Siluriformes contains the highest number of representatives of the genus *Cucullanus*. *Cucullanus pinnai*, *C. zungaro*, *C. pauliceae* (Syn. *C. schubarti* Travassos, 1947), *C. oswaldocruzi*, *C. grandistomis*, *C. brevisciculus*, *C. pimelodellae*, *C. pinnai pterodorasi*, *C. pseudoplatystoma*, *C. heliomartinsi*, and *C. ageneiosus* were described to parasitize Brazilian fish in three different aquatic environments. *Cucullanus bagre* described in *Bagre bagre* in Cayenne, French Guiana, and the North Atlantic Ocean was redescribed in Brazil by Pereira et al. (2015) in the same host in Angra dos Reys Bay, state of Rio de Janeiro, Brazil, South Atlantic Ocean.

Cucullanus marajoara n. sp. parasitizes *C. psittacus* (Tetradontiformes), which was collected in municipality of Soure, Marajó Archipelago, state Pará, but differs in habitat, biome, and host order from *C. cirratus, C. pulcherrimus, C. carioca, C. rougetae, C. tucunarensis, C. protrudens*, and *C. pseudopercis*, which are parasites of fish of the order Perciformes, which are mostly marine. *C. tucunarensis* and *C. opisthoporus*, parasites of freshwater fish of the genus *Cichla* (Cichliformes) in northern Brazil; differ morphologically from the new species because they present sclerotized spines at the tail end in the ventral region.

Hosts of the order Perciformes, which are mostly marine, include *Cucullanus cirratus*, *C. pulcherrimus*, *C. carioca*, *C. rougetae*, *C. protrudens* and *C. pseudopercis* followed by hosts of the order Tetradontiformes, including *C. dodsworthi* and *C. brevicaudatus*, and the orders Characiformes, Gymnotiformes, Ophidiiformes, Anguilliformes, and Lophiiformes, including *C. mogi*, *C. rhamphichthydis*, *C. genypteri*, *C. pedroi*, and *C. gastrophysi*, respectively.

Cucullanus dodsworthi and *C. brevicaudatus* are the only species described parasitizing fish of the order Tetradontiformes. *C. dodsworthi* was originally described in *Sphoeroides testudineus* in Brazil (BARRETO, 1922). Campana-Rouget (1957) redescribed this species parasitizing *Lagocephalus laevigatus* in Senegal, Africa, and Mejía-Madrid & Guillén-Hernández (2011) redescribed the species parasitizing *Sphoeroides testudineus* in Mexico. *Cucullanus marajoara* n. sp. presents 10 pairs of cloacal papillae distributed in five ventral precloacal pairs, an unpaired papilla on the upper lip of the cloaca, and five postcloacal pairs (pairs No. 6, 8, and 10 are ventral, pair No. 7 is lateral, and pair No. 9 is dorsal); one pair of lateral phasmids located between pairs No. 8 and 10. *C. dodsworthi* also has ten pairs of papillae, but their distribution is unique [three ventral precloacal pairs, four adcloacal pairs, one unpaired precloacal papillae on anterior precloacal lip and three postcloacal pairs (two ventral pairs and one lateral pair)]. Moreover, Barreto (1922) and López-Caballero et al. (2009) did not observe protruded cloacal lips, which occur in the new species.

Cucullanus brevicaudatus, a parasite of *B. capriscus* (Tetraodontiformes: Balistidae), differs from the new species by the host family, habitat (marine), morphology of the gubernaculum well sclerotised, thin distally, enlarged and with small ornament proximally, tail size, and distribution of the caudal papillae (six pairs of precloacal papillae, one pair of adcloacal papillae, and three pairs of posterior papillae).

Cucullanus marajoara n. sp. differs from other similar species that parasitize hosts of order Siluriformes by the host species and habitat, with the exceptions of *C. oswaldocruzi*, which is a parasite of the freshwater fish *Paulicea luetkeni* (Syn. *Zungaro zungaro*) found in the Curuá river, and *C. ageneiosus*, which is a parasite of the estuarine fish *Ageneiosus ucayalensis*; both of these species occur in Pará in the same zoogeographic region as the new species. Morphologically, *Cucullanus marajoara* n. sp. differs from these two species by the distribution of the cloacal papillae, including the presence of five precloacal pairs (the first pair is located anterior to the precloacal sucker, whereas pairs No. 2, 3, 4, and 5 are ventral and located posterior to the precloacal sucker) and five postcloacal pairs (pairs No. 6, 8, and 10 are ventral, pair No. 7 is lateral, and pair No. 9 is dorsal). The location of the phasmids between pairs No. 8 and 10 is a diagnostic feature of the new species and differs from *C. ageneiosus*, in which the phasmids are located immediately posterior to the tenth pair of papillae. In addition to belonging to a different host group, *C. oswaldocruzi* and *C. ageneiosus* do not present a protuberant cloacal upper lip and do not have an odd papilla on this lip, as has been observed in *Cucullanus marajoara* n. sp.

Cucullanus mogi (parasite of Characirfomes) and *C. rhamphichthydis* (parasite of Gymnotiformes) differ from the new species based on the host order and other morphological characteristics. *Cucullanus mogi* does not have a gubernaculum, whereas this structure is present in *Cucullanus marajoara* n. sp. (0.06–0.08 mm). *Cucullanus rhamphichthydis* parasitizes the freshwater fish *Rhamphichthys rostratus* in Paraná, Brazil, and only females have been used for the description of the species. The morphological characteristics that are important for the distinction of these species from the new species include the position of the nerve ring (0.354–0.476), deirids (1.63), excretory pore (1.81–2.30), and non-protruding vulval lips in females. Additional morphometric comparisons between *Cucullanus marajoara* n. sp. and the other species found in Brazil are presented in Table 1.

Table 1. Morphometric characteristics of *Cucullanus marajoara* n. sp. parasite of *Colomesus psittacus* in the Marajó Archipelago, state of Pará, eastern Amazon, Brazil.

Caracteres	*Cucullanus marajoara* n. sp.		*Cucullanus cirratus*		*Cucullanus pulcherrimus*		*Cucullanus dodsworthi*		*Cucullanus pinnai*		*Cucullanus zungaro*		*Cucullanus pauliceae*	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Host	*Colomesus psittacus*		*Micropogonias undulatus*		*Caranx lugubris*		*Spheroides testudineus*		*Pimelodus clarias*		*Paulicea luetkeni*		*Paulicea luetkeni*	
Group of host	(Tetraodontiformes)		(Perciformes)		(Perciformes)		(Tetraodontiformes)		(Siluriformes)		(Siluriformes)		(Siluriformes)	
Locality	Soure, Arquipélago do Marajó, Pará, Brazil		Macaé, RJ, Brazil		Ilha de Trindade, ES. Brazil		Baia da Ganabara. RJ. Brazil		Rio Guaçu. SP. Brazil		Rio Paraná. PR. Brazil		Rio Paraná, PR. Brazil	
Environment	Brackish		Marine		Marine		Marine		Freshwater		Freshwater		Freshwater	
Author	–		Mueller (1777)		Barreto (1918)		Barreto (1922)		Travassos, Artigas & Pereira (1928)		Vaz & Pereira (1934)		Vaz & Pereira (1934)	
Length	**6–10.6**	**7.55–12.12**	10.9	13.2	13.30	15.90	9.54	14.4	5.07–11.88	5.07–12.31	5.40–11.60	8.3	18.5	20.30
Esophagus	**0.63–0.91**	**0.76–0.91**	0.99	1.16	1.59	–	0.71–0.91[a]	0.95–1.06[a]	0.54–0.97	0.61–0.95	0.898	–	1.50	–
Vulva (Position)	**Postequatorial**		Postequatorial		Equatorial		Postequatorial		Postequatorial		Equatorial		Postequatorial	
Precloacal papillae	**5ve+1u**		6		3ve		3 ve+1u[a]		5ve		5		3	
Adcloacal papillae	**–**		1		4 (3 ve–1L)		4		1		–		3 (2 sv–1L)	
Posterior papillae	**5 (3ve–1L+1dL–1ph)**		4		3 (2 ve–1L)		3 (2ve–1L)[a]		4 (2 sv–2L–1ph)		5 (3 sv–2L–1ph)		4 (2 sv–2L--1ph)	
Spicule length	**0.56–1**		0.88		0.62		1.023		0.345–0.681		0.640–0.780		1.2	
Gubernaculum	**0.06–0.08**		0.16		0.13		0.114		0.06 –0.07		0.075		–	
Cloacal lips	**Protruded**		No protruded		No protruded		No protruded		No protruded		No protruded		Protruded	
Reference	**From this study**		Vicente & Santos (1973)		Barreto (1922)		(Barreto, 1922)		Moravec (1998)		Moravec (1998)		Moravec (1998)	

Caracteres	*Cucullanus schubarti*		*Cucullanus mogi*	*Cucullanus carioca*		*Cucullanus rougetae*	*Cucullanus bagre*		*Cucullanus oswaldocruzi*		*Cucullanus grandistomis*		*Cucullanus brevispiculus*	
	Male	Female	Male	Male	Female	Male	Male	Female	Male	Female	Male	Female	Male	Female
Host	*Paulicea luetkeni*		*Leporinus* sp.	*Pinguipes brasilianus*		*Plagioscion auratus*	*Bagre bagre*		*Paulicea luetkeni*		*Pseudodora niger*		*Auchenipterus nuchalis*	
Group of host	(Siluriformes)		(Characiformes)	(Perciformes)		(Perciformes)	(Siluriformes)		(Siluriformes)		(Siluriformes)		(Siluriformes)	
Locality	Rio Mogi Guaçú, SP. Bazil		Rio Mogi Guaçú, SP. Bazil	Baia da Guanabara. RJ. Brazil		Macaé. RJ. Brazil	Angra dos Reis Bay, RJ. Brazil		Rio Amazonas. PA. Brazil		Rio Amazônas, AM. Brazil		Rio Paraná. PR. Brazil	
Environment	Freshwater		Freshwater	Marine		Marine	Marine		Freshwater		Freshwater		Freshwater	
Author	Travassos (1947)		Travassos (1948)	Vicente & Fernandes (1973)		Vicente & Santos (1974)	Petter (1974)		Santos, Vicente & Jardim (1979)		Ferraz & Thatcher (1988)		Moravec, Kohn & Fernandes (1993)	
Length	14.5–15.6	19.2	8.7	4.47–7.71	5.88	3.71	11.3–19	13.4–18.6	17.13–18.22	18.22	3.70–4.70	3–7.40	9.56–9.86	8.55–11
Esophagus	1.4–1.8	1.4–1.8	0.70	0.79–0.83	0.72	0.63	1.2–1.4	1.2–2.0	1.52	1.59	0.56–0.68	0.45–0.79	0.76–0.81	0.95–1.03
Vulva (Position)	Postequatorial		–	Postequatorial		–	Postequatorial		Postequatorial		Postequatorial		Postequatorial	
Precloacal papillae	2		5	6		6	3 (2v–1sv)+1u		5		4		5	

[a]basede on Mejía-Madrid & Aguirre-Macedo (2011); Abbreviations: v = ventral papillae; sd = subdorsal papillae; sv = subventral papillae; L = lateral papillae; dL = dorsolateral papillae; RJ = Rio de Janeiro state; ES = Espírito Santo state; SP = São Paulo state; PR = Paraná state; AM: Amazonas state; PA: Pará state.

Table 1. Continued...

Caracteres	*Cucullanus schubarti*		*Cucullanus mogi*	*Cucullanus carioca*		*Cucullanus rougetae*	*Cucullanus bagre*		*Cucullanus oswaldocruzi*		*Cucullanus grandistomis*		*Cucullanus brevispiculus*	
	Male	Female	Male	Male	Female	Male	Male	Female	Male	Female	Male	Female	Male	Female
Adcloacal papillae	2		–	–		–	4 (3sv–1L)		–		4		–	
Posterior papillae	5		6 (5ve–1L)	4		5	3 (2sv–1L)		6 (+1ph)		3		5 (3sv–2L–1ph)	
Spicule length	1–1.4		0.68–0.76	0.91–1.05		0.96	0.360–0.429		1.14		0.78		0.210	
Gubernaculum	0.1		Absent	0.06		0.06	0.172–0.182		0.09		–		0.075–0.084	
Cloacal lips	–		No protruded	No protruded		No protruded	Protruded		No protruded		No protruded		No protruded	
Reference	Travassos (1947)		Travassos (1947)	Vicente & Fernandes (1973)		Vicente & Santos (1974)	Pereira et al. (2015)		Moravec (1998)		Moravec (1998)		Moravec (1998)	

Caracteres	*Cucullanus Pimelodellae*	*Cucullanus pinnai pterodorasi*		*Cucullanus pseudoplatystomae*		*Cucullanus rh-amphichthydis*	*Cucullanus genypteri*		*Cucullanus heliomartinsi*		*Cucullanus pedroi*	
	Male	Male	Female	Male	Female	Female	Male	Female	Male	Female	Male	Female
Host	*Pimelodella lateristriga*	*Pseudoplatystoma corruscans*		*Pseudoplatystoma corruscans*		*Rhamphichthys rostratus*	*Genypterus brasiliensis*		*Parauchenipterus stiatulus*		*Conger orbignianus*	
Group of host	(Siluriformes)	(Siluriformes)		(Siluriformes)		(Gymnotiformes)	(Ophidiiformes)		(Siluriformes)		(Anguilliformes)	
Locality	Rio Paraná. PR. Brazil	Rio Paraná. PR. Brazil		Rio Paraná. PR. Brazil		Santa Helena. PR. Brazil	Cabo Frio, Rj. Brazil		Rio Doce. MG. Brazil		Cabo Frio, Rj. Brazil	
Environment	Freshwater	Freshwater		Freshwater		Freshwater	Marine		Freshwater		Marine	
Author	Moravec, Kohn & Fernandes (1993)	Moravec, Kohn & Fernandes (1993)		Moravec, Kohn & Fernandes (1993)		Moravec, Kohn & Fernandes (1993)	Sardella, Navone & Timi (1997)		Moreira, Rocha & Costa (2000)		Timi & Lanfranchi (2006)	
Length	3.74–4.92	6.83–9.90	8.60–10.35	9.09–11.83	8.57–15.16	9.34–12.35	17.6–21.9	18.3–27.5	11.18	17.45	10.5–15.2	19.4–25.6
Esophagus	0.57–0.66	0.748–0.884	0.843–0.870	1.09–1.44	1.10–1.47	1.17–1.35	1.8–2.4	1.8–2.5	0.80	0.93	1.3–1.5	1.5–1.6
Vulva (Position)	–	Postequatorial		Postequatorial		Postequatorial	Postequatorial		Postequatorial		Postequatorial	
Precloacal papillae	5 (sv)	5		5–6		–	3v + 1u		5		4 +1u	
Adcloacal papillae	1	1		1		–	4 (3sv–1L)		1		3 (2sv–1L)	
Posterior papillae	5 (3sv–2L)	4 (2sv–2L–1ph)		4 (2sv–2L–1ph)		–	4 (2sv–1sd–1ph)		5 (3sv–2L)		4(2sv–1sd–1ph)	
Spicule length	0.21–0.33	0.544–0.558		0.486–0.534		–	1–1.3		0.28		1.1–1.6	
Gubernaculum	0.03–0.04	0.069		0.075– 0.084		–	0.047–0.055		0.09		0.232–0.264	
Cloacal lips	No protruded	Protruded		No protruded		–	No protruded		No protruded		Protruded	
Reference	Moravec et al. (1993)	Moravec et al. (1993)		Moravec et al. (1993)		Moravec et al. (1997)	Vieira et al. (2015)		Moreira et al. (2000)		Vieira et al. (2015)	

[a]basede on Mejía-Madrid & Aguirre-Macedo (2011); Abbreviations: v = ventral papillae; sd = subdorsal papillae; sv = subventral papillae; L = lateral papillae; dL = dorsolateral papillae; RJ = Rio de Janeiro state; ES = Espírito Santo state; SP = São Paulo state; PR = Paraná state; AM: Amazonas state; PA: Pará state.

Table 1. Continued...

Caracteres	*Cucullanus ageneiosus*		*Cucullanus tucunarensis*		*Cucullanus brevicaudatus*		*Cucullanus gastrophysi*		*Cucullanus protrudens*		*Cucullanus pseudopercis*		*Cucullanus opisthoporus*	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Host	*Ageneiosus ucayalensis*		*Cichla piquiti*		*Balistes capriscus*		*Lophius gatrophysus*		*Pargus pargus*		*Pseudopercis semifasciata*		*Cichla melaniae*	
Group of host	(Siluriformes)		(Cichliformes)		(Tetraodontiformes)		(Lophiiformes)		(Perciformes)		(Perciformes)		(Cichliformes)	
Locality	Baia do Guajará. PA. Brazil		Rio Tocantins. TO. Brazil		Angra dos Reis Bay. RJ. Brazil		Cabo Frio. RJ. Brazil		Cabo Frio. RJ. Brazil		Cabo Frio. RJ. Brazil		Rio Xingu. PA. Brazil	
Environment	Brackish		Freshwater		Marine		Marine		Marine		Marine		Freshwater	
Author	Giese, Furtado, Lanfredi & Santos (2010)		Lacerda, Takemoto, Marchiori, Martins & Pavanelli (2013)		Pereira, Vieira & Luque (2014)		Pereira, Vieira & Luque (2015)		Pereira, Vieira & Luque (2015)		Pereira, Vieira & Luque (2015)		Pereira & Luque (2017)	
Length	3.65–8.94	10–12	4.50–5.87	4.75–7	2.5–3.6	2.6–4.5	12.3–16.6	14.8–20.2	10.5–12.3	14.5–17	8.9–12.1	10. 8–12.7	4.6–5.9	5.6
Esophagus	0.51–0.57	0.94–1	0.65–0.75	0.78–0.84	0.471–0.591	0.539–0.650	1.13–1.33	1.23–1.42	1–1.2	1.13–1.37	0.78–1	0.8–1.1	0.382–0.472	0.507
Vulva (Position)	Postequatorial		Postequatorial		Postequatorial		Postequatorial		Pre–equatorial		Postequatorial		Postequatorial	
Precloacal papillae	5sv		6		6 (5sv–1L)		5 sv + 1u		4 sv +1u		5 (4sv–1L+1u)		5v + 1u	
Adcloacal papillae	–		2		1		1 sv		2 sv		2		2 (1sv–1L)	
Posterior papillae	5 (3sv–2L–1ph)		4		3 (1sv–1v–1sd)		3 (2sv–1sd–1ph)		4 (2sv–1sd–1L–1ph)		3 (2sv–1sd–1ph)		3 (2sv–1sd–1ph)	
Spicule length	0.14–0.18		0.96 –1.28		0.669–0. 853		0.97–1.29		0.400–0.415		1–1.5		0. 739–1.18	
Gubernaculum	0.08–0.10		0.08–0.10		0.080–0.087		0.107–0.135		0.091–0.103		0.178–0.196		0.048–0.065	
Cloacal lips	No protruded		–		Protruded		Not protuded		Protruded		Protruded		Not protruded	
Reference	Giese et al. (2010)		Lacerda et al. (2013)		Pereira et al. (2014)		Vieira et al. (2015)		Vieira et al. (2015)		Vieira et al. (2015)		Pereira & Luque (2017)	

[a]basede on Mejía-Madrid & Aguirre-Macedo (2011); Abbreviations: v = ventral papillae; sd = subdorsal papillae; sv = subventral papillae; L = lateral papillae; dL = dorsolateral papillae; RJ = Rio de Janeiro state; ES = Espírito Santo state; SP = São Paulo state; PR = Paraná state; AM: Amazonas state; PA: Pará state.

Vieira et al. (2015) studied marine fish and described *C. gastrophysis*, which is a parasite of *Lophius gastrophysus* (Lophiformes), and redescribed *C. genypteri* parasitizing *Genypterus brasiliensis* (Ophidiiformes), *C. pedroi* parasitizing *Conger orbignianus* (Anguilliformes), and *C. cirratus* parasitizing *Urophycis brasiliensis* (Gadiformes) in the states of Rio de Janeiro and Rio Grande do Sul. *Cucullanus marajoara* n. sp. differs from these species in the zoogeographical region, host order, and absence of adcloacal papilla, as observed in the four marine species *C. gastrophysis* (one pair, 1sv), *C. genypteri* (four pairs, 3sv–1L), *C. pedroi* (three pairs, 2sv–1L), and *C. cirratus* (four pairs, 3sv–1L).

In conclusion, this study described *Cucullanus marajoara* n. sp. as the first species of the genus parasitizing *C. psittacus* in Marajó Archipelago region, in state of Pará, in eastern Amazon. This species is the second species of the genus living in estuarine environments in Brazil and adds new data to the diversity of fish parasites of the Tetraodontiformes in the Neotropical region.

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