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ORIGINAL RESEARCH ARTICLE

Morphological description of *Chaetostoma thomsoni* Regan, 1904 (Siluriformes, Loricariidae), an endemic fish species from Colombia

Descripción morfológica de Chaetostoma thomsoni Regan, 1904 (Siluriformes, Loricariidae), una especie íctica endémica de Colombia

Descrição morfológica de Chaetostoma thomsoni Regan, 1904 (Siluriformes, Loricariidae), uma espécie de peixe endêmica da Colômbia

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Abstract

Background: the Porce River basin, where the Porce II and Porce III reservoirs are located, is home to a wide variety of endemic ichthyofauna species, most of which still do not have descriptions of their anatomy and histology. *Chaetostoma thomsoni*, known as "Striped rubbernose plecostomus" and Cucha or Carachama in South America. It is a teleost fish of the order Siluriformes, family Loricariidae, which is usually abundant in the ecosystems of rivers and streams with fast currents and moderate slopes. This species is abundant in the Magdalena–Cauca River basin in Colombia. **Objective:** This study aimed to describe the anatomical and histological characteristics of the skin and the internal organs of *C. thomsoni* from the Porce River basin. **Methods:** for this, 37 specimens of *C. thomsoni* were captured in streams by electrofishing or cast net. The specimens were immersed in Eugenol solution (300 mg/L) as euthanasia, then preserved in 10% buffered formalin solution, labeled, and stored individually in Falcon tubes. Subsequently, the fish were transferred to the Animal Anatomy Laboratory of the University of Antioquia to perform the biometry, dissection, and sample collection. **Results:** the complete morphometric study of the species was obtained, in addition to a detailed description of its skin and internal anatomy, where it was possible to identify macro and microscopic structures of organs such as intestines, hepatopancreas, spleen, kidney, urinary bladder, gonads, among others. This detailed anatomical description provides valuable information about the health of the animals and aspects of applied anatomy, such as knowledge of the appropriate puncture site for taking blood samples through cardiopuncture. Another interesting finding was the shape of the cephalic kidney, with a bifurcated arrangement cranially, partially enveloping the brain. In addition, both the cephalic kidney and its caudal portion showed interstitial hematopoietic tissue, endocrine, and immunological functions. The Stannius corpuscles, as in another fish species, in *C. thomsoni*, are evident in two nodules at the last third of the caudal kidney. **Conclusion:** completing this anatomical description is essential for future research that will help generate new knowledge promoting the protection of endemic Colombian ichthyofauna.

Keywords: *electrofishing; endemic fish; histology; morphology; morphometry; reservoirs.*

Resumen

Antecedentes: la cuenca del río Porce, donde se ubican los embalses de Porce II y Porce III, alberga una gran variedad de especies endémicas de ictiofauna, la mayoría de las cuales aún no cuentan con descripciones de su anatomía e histología. *Chaetostoma thomsoni*, conocido como "Plecostomus nariz de goma rayado" y Cucha o Carachama en Sudamérica. Es un pez teleósteos del orden Siluriformes, familia Loricariidae, que suele ser abundante en los ecosistemas de ríos y arroyos de corrientes rápidas y pendientes moderadas. Esta especie es abundante en la cuenca del río Magdalena–Cauca en Colombia. **Objetivo:** Este estudio tuvo como objetivo describir las características anatómicas e histológicas de la piel y los órganos internos de *C. thomsoni* de la cuenca del río Porce. **Métodos:** Para ello se capturaron 37 ejemplares de *C. thomsoni* en arroyos mediante electropesca o atarraya. Las muestras se sumergieron en una solución de eugenol (300 mg/l) como eutanasia, luego se conservaron en una solución tamponada de formalina al 10 %, se etiquetaron y almacenaron individualmente en tubos Falcon. Posteriormente, los peces fueron trasladados al Laboratorio de Anatomía Animal de la Universidad de Antioquia para realizar la biometría, disección y recolección de muestras. **Resultados:** Como resultado se obtuvo el estudio morfométrico completo de la especie, además de una descripción detallada de su piel y anatomía interna, donde se pudo identificar estructuras macro y microscópicas de órganos como intestinos, hepatopáncreas, bazo, riñón, orina. vejiga, gónadas, entre otros. Esta detallada descripción anatómica proporciona información valiosa sobre la salud de los animales y aspectos de la anatomía aplicada, como el conocimiento del sitio de punción adecuado para la toma de muestras de sangre, mediante la cardiopunción. Otro hallazgo interesante fue la forma del riñón cefálico, con una disposición bifurcada cranealmente, envolviendo parcialmente el cerebro. Además, tanto el riñón cefálico como su porción caudal mostraron tejido hematopoyético intersticial, funciones endocrinas e inmunológicas. En los corpúsculos de Stannius, como en otra especie de pez, en *C. thomsoni*, se evidencian dos nódulos en el último tercio del riñón caudal.

Conclusión: Completar esta descripción anatómica es fundamental para futuras investigaciones que ayuden a generar nuevos conocimientos que promuevan la protección de la ictiofauna endémica colombiana.

Palabras clave: *electropesca; embalses; histología; morfología; morfometría; peces endémicos.*

Resumo

Antecedentes: a bacia do rio Porce, onde se localizam as usinas de Porce II e Porce III, alberga uma grande variedade de ictiofauna endémica, a maioria das quais ainda não possui descrições da sua anatomia e histologia. *Chaetostoma thomsoni,* conhecido como "Plecostomus nariz de goma rayado", e Cucha ou Carachama na América do Sul, é um peixe teleósteo da ordem Siluriformes, família Loricariidae, que costuma ser abundante nos ecossistemas de rios e ribeiros com correntes rápidas e declives moderados. Esta espécie é abundante na bacia do rio Magdalena–Cauca, na Colômbia. **Objetivo:** Este estudo teve como objetivo descrever as características anatómicas e histológicas da pele e dos órgãos internos de *C. thomsoni* da bacia do rio Porce. **Métodos:** para isso, foram capturados 37 exemplares de *C. thomsoni* em ribeiros através de pesca elétrica ou tarrafa de pesca. Os espécimes foram imersos em solução de Eugenol (300 mg/L) como eutanásia, depois conservados em solução de formalina tamponada a 10%, etiquetados e armazenados individualmente em tubos Falcon. Posteriormente, os peixes foram transferidos para o Laboratório de Anatomia Animal da Universidade de Antioquia para a realização de biometria, dissecção e toma de amostras. **Resultados:** obteve-se o estudo morfométrico completo da espécie, bem como uma descrição detalhada da sua pele e anatomia interna, onde foi possível identificar estruturas macro e microscópicas de órgãos como o intestino, hepatopâncreas, baço, rim, sistema urinário bexiga, gónadas, entre outros. Esta descrição anatómica detalhada fornece informações valiosas sobre a saúde dos animais e aspetos da anatomia aplicada, como o conhecimento do local de punção adequado para a recolha de amostras de sangue, através de cardiopuntura. Outro achado interessante foi a forma do rim cefálico, com uma disposição bifurcada cranialmente, envolvendo parcialmente o cérebro. Além disso, tanto o rim cefálico como a sua porção caudal apresentavam tecido hematopoiético intersticial, funções endócrinas e imunológicas. Nos corpúsculos de Stannius, como noutra espécie de peixe, em C. thomsoni, são evidentes dois nódulos no último terço do rim caudal. **Conclusão**: O preenchimento desta descrição anatómica é essencial para futuras pesquisas que ajudarão a gerar novos conhecimentos que promovam a proteção da ictiofauna endémica da Colômbia.

Palavras-chave: *histologia; morfologia; morfometria; peixes endémicos; pesca elétrica; reservatórios.*

Introduction

Colombia has diverse aquatic ecosystems rich in endemic species. According to the Colombian Association of Ichthyologists, the country has 419 described fish species (Do Nascimiento et al., 2024). Native fish are of great importance in the biodiversity of aquatic ecosystems. Additionally, they are a source of food for riverside communities and a protein resource for multiple animal species (Restrepo et al., 2022). However, this ichthyofauna faces significant threats in its ecosystems due to various anthropogenic activities, such as extensive livestock production, the cultivation of introduced fish and agriculture (Chará, 2002), as well as illicit activities, among which is mining extraction that releases several pollutants into water sources (Mancera-Rodríguez & Álvarez-León, 2006). The alteration of ecosystems caused by hydroelectric plants for energy generation directly affects the reproductive cycle of multiple endemic fish species (Jiménez-Segura *et al.,* 2014a). The imminent decrease in biodiversity in freshwater river systems makes it highly relevant to carry out studies on these environments and the fish species that live there.

The Porce River is inserted around the eastern massif of Antioquia, rising in Alto de San Miguel, south of the city of Medellín, at about 2,660 meters above sea level. Subsequently, it crosses the central region of the department of Antioquia to the northeast until it flows into the Nechí River, a tributary of the Cauca River. The riverbed, from its source to its passage through the municipality of Barbosa (Antioquia) at 680 meters above sea level, is called the Medellín River; after this site, it takes the name of the Porce River (Loaiza et al., 2018).

Many endemic and introduced fish fauna live in the Porce River basin and its Porce II and Porce III reservoirs. Within the introduced ichthyofauna, we find species such as *Oreochromis niloticus*, *Xiphophorus hellerii*, and *Poecilia reticulata* (Huertas *et al.*, 2022). Among the endemic ichthyofauna are species such as *Chaetostoma spp., Saccodon spp., Parodon spp., Astyanax spp.,* and *Brycon henni*, among others (Jiménez-Segura et al., 2014). Some of the introduced species have already been widely studied. However, most endemic species lack morphometric, anatomical, or histological descriptions.

Knowledge of fish anatomy is of utmost importance in determining the normal physiological conditions of each species. Among the most relevant structures to highlight is the gonadal anatomy, which allows for determining the reproductive physiology of the fish, which is fundamental in the preservation of ecosystems. In addition, this physiology is directly influenced by the environment in which it lives the fish (Rodríguez & Carrillo, 2001; Pankhurst & Munday, 2011). Therefore, the anatomical and histological study of the gills and liver also allows us to detect pollution effects since these are considered the primary organs affected by river water pollution (Torres *et al.,* 2010; Malik *et al.,* 2020).

Chaetostoma thomsoni is a teleost fish of the order Siluriformes, family Loricariidae, referred to as an armored fish with a sucker mouth typical of a tropical climate (ITIS, 2024). *C. thomsoni* is widely distributed in swift-flowing rivers and streams with 20°C - 22°C water temperature, with moderate slopes, rocky bottoms, and periphytic vegetation along the basins of the Magdalena, Cauca, Sinú, and Cesar rivers in Colombia (Lasso et al., 2011; Restrepo-Santamaria et al., 2022).

Currently, *C. thomsoni* population is stable and listed as Least Concern on the IUCN Red List of Threatened Species (Jiménez-Segura et al., 2016). It is a food source for riverside communities in its distribution basins (Lasso et al., 2011). It corresponds to herbivorous, detritivorous, and algivorous species. Thanks to its specialized mouthparts, it can cling to rocks and the bottom to feed by scraping algae and detritus (Zúñiga-Upegui, 2005; Maldonado-Ocampo et al., 2005). *C. thomsoni* is described as a brownish fish with small spots on the fin rays, a body depth less than its total length, and a head size three times that of the body. Each operculum is armed with 4 to 5 odontodes, and its body, which lacks scales, is covered dorsally by 24 to 25 bony plates (Regan, 1904; Reis et al., 2003; Jiménez-Segura et al., 2014).

Currently, the existing description of the C. *thomsoni,* another endemic Colombian fish species, is based on an external morphological description for the purposes of taxonomic classification and ecosystem monitoring of water sources. However, the skin's and internal organs' anatomy and histology are unknown. This knowledge becomes essential for better understanding the species, its relationship with the environment, and its adaptive processes. This study aims to describe for the first time the anatomical and histological characteristics of the internal organs and skin of *C. thomsoni* inhabiting the Porce River basin.

Materials and methods

Ethical statement

This study was conducted with the approval of the Ethics and Animal Experimentation Committee of the University of Antioquia. It received ethical endorsement for the project "*Respuesta de la Ictiofauna a la formación de embalses en los Andes Colombianos*" with Protocol Number 138 dated February 9, 2021. Additionally, this project obtained permission from the National Authority of Environmental Licenses (ANLA) to mobilize biological diversity specimens.

Study location

Sampling was carried out in the Porce River basin, in the area of influence of the Porce II and Porce III reservoirs, in the northwest of the department of Antioquia, Colombia. The specimens of interest were obtained in the different streams belonging to the municipalities of Amalfi, Anorí, Gómez Plata, and Santa Rosa de Osos (Figure 1). These streams have slight to moderate slopes, sand, eroded margins, muddy bottoms, and abundant vegetation. Additionally, the waters come from the Guadalupe waterfall, close to the town of Puente Acacias, from where you can see the discharge of the Porce II reservoir that continues to the Porce River until reaching the Porce III reservoir.

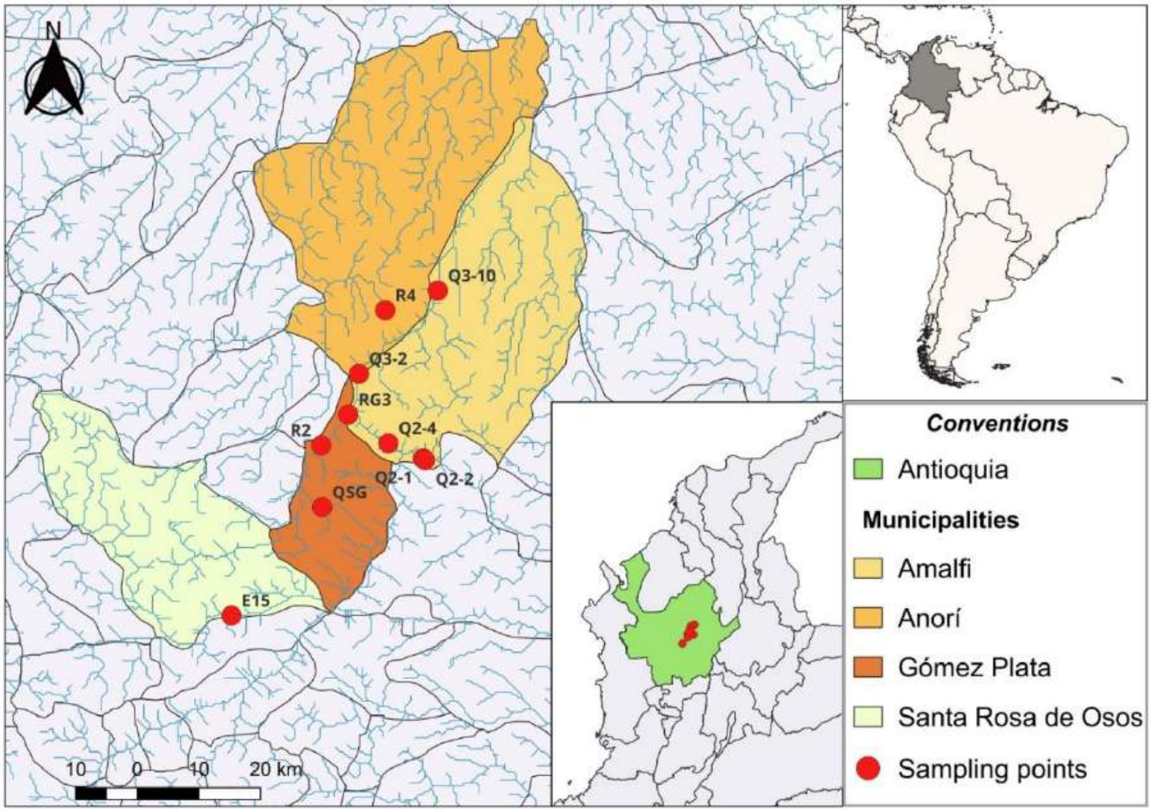

Figure 1. Map of sampling areas in the department of Antioquia, Colombia. The red points correspond to the sampling locations where the fish were captured. Q2-1 Canana stream, R2 Guadalupe River after discharge, Q3-10 El Boquerón stream, Q2-4 Picardía stream, Q2-2 Cancana stream mouth, R4 Porce III reservoir, Q3-2 El Saíno stream, QSG Santa Gertrudis stream, E15 Río Grande (Mocorongo), RG3 Guadalupe River.

Fish and fishing methods

Fish captures in reservoir environments were conducted between April 2022 and April 2023, employing electrofishing and cast nets. A 100 m stretch along the watercourse was selected at each sampling site, and species of interest, specifically *Chaetostoma thomsoni* (n = 37), were targeted. Additionally, information such as species, origin, collection date, and biometric data, including length (mm), height (mm), weight (g), and a description, was recorded.

For euthanasia, each fish was immersed in a Eugenol solution (300 mg/L). Immediately, they were fixed in a 10% buffered formalin solution at room temperature prepared in distilled water by tissue injection with a 1 ml syringe 25 Ga ½ inch and total immersion in a Falcon-type container (screw cap) or resealable bags for larger specimens for at least one week. They were then transported to the Animal Anatomy Laboratory at the Universidad de Antioquia for further study.

Laboratory methods

Biometrics and external anatomy

In the Animal Anatomy Laboratory of the University of Antioquia, the biometric data of the animals were taken with the help of an electronic Pocket Scale (MH - 200) and analytical balance (ADAM model PW 124) for the internal organs. Subsequently, body measurements (mm) were taken with the help of a digital Vernier caliper (Uyulstools, CLD006). For data analysis, the specimens were grouped according to their total length (TL) into juveniles < 70 mm and adults > 70.1 mm. Animals under 70 mm do not show gonadal development in any of the sampled locations. The information was recorded in an Excel database for subsequent processing.

Initially, the specimens were placed in a dissection tray, and detailed biometry was performed. The total length of the specimens was recorded from the mouth to the tip of the caudal fin, and the weight of the formalin-fixed specimens was taken. The biometrics included the measurement by regions, the recognition of the external anatomy, and the number of bone plates that cover the fish were counted: from the head to the beginning of the dorsal fin, from this point to the beginning of the adipose fin and from the anal fin to the caudal fin. In the head region, we determined the total size, width, length, and height in millimeters (mm), and the number of odontodes present in the opercula and rostral to them.

The length of the trunk region was measured from the operculum to the urogenital orifice. Length measurements were taken according to the bony radius (spines) of each pectoral and pelvic fin, as well as the number of spines and rays (soft) present in each fin. In the dorsal fin, the height and length according to the bone radius and length were recorded, as well as the number of spines and rays. In the case of the adipose fin, the presence of a spine was found, with which the measurement of its length was determined.

The caudal region was determined caudal to the anal orifice until the end of the caudal fin; the total measurement of this region and the measurement of the caudal peduncle were recorded. In the anal fin, the length measurement was taken according to the bone radius and the number of spines and rays. Finally, the length of the caudal fin was determined, taking as reference the length of the bony radius, both dorsal and ventral, and the number of spines and rays.

Animal dissection

Entomological and conventional dissection equipment was used to carry out the dissection; a number 10 scalpel blade with a number 3 handle was used to incise. For proper handling of the tissues, clawless dissection forceps were used, and in blunt dissection, Metzenbaum scissors were used. The dissections were performed with the specimen in ventral view to facilitate access to the coelomic cavity, making a cut in the ventral median line of the specimens, starting from the caudal part of the labial suction cup up to 2 mm cranial from the urogenital orifice. A stereoscope (Nikon, SMZ-1) was used to better observe the structures during dissection.

For the proper identification and description of the different structures, samples were taken for histological study. They were preserved in wide-mouth glass or plastic jars with screw caps labeled with the name of the structure and the number of specimens to which it corresponded. In the case of the smaller samples, they were placed on absorbent paper, marked with a pencil, and sealed with staples.

Female reproductive stages description

C. thomsoni presents more than one group of developing oocytes and is characteristic of species that spawn several times within the same spawning season (Sierra-de la Rosa, 2007). In the present study, the maturation stage of oocytes was classified into three developmental stages: a) oocytes in mature stage three or pre-spawning, with a diameter > 2 mm; b) oocytes in maturation phase two, with a diameter of 1-2 mm; and c) oocytes in maturation phase one, with a diameter < 1 mm (Loaiza et al., 2018).

Histological procedures

The formalin‒ fixed tissues extracted during the dissection were sent to the Pathology Laboratory of the University of Antioquia. For the analysis of the integumentary system, the carcasses were subjected to decalcification with 10% nitric acid (HNO3) for 24 hours. These carcasses were subjected to serial cuts, longitudinal in some individuals (n = 3) and transverse in others (n = 2). These tissues were processed in an automatic tissue processor (Thermo Excelsior AS500), dehydrated in increasing ethanol concentrations (70-100%), and cleared with xylene. After being embedded in histological paraffin, the blocks were cut at 4 µm using a microtome (Microm HM325, Thermo Scientific). Finally, the slides were stained with hematoxylin and eosin for subsequent analysis by light microscopy (Olympus, BX53).

Image capture

A photographic record of the external anatomy and the dissections carried out with the help of a camera (Nikon, D5500) was made. Additionally, stereoscopic photographs were taken with a stereoscope (Nikon, SMZ-1). Images were also taken with an electronic stereoscope (Olympus, SZ2-ILST). The micrographs were made with a microscope and adapted camera (Olympus, BX53).

Data Analysis

For the morphometric description of captured *C. thomsoni*, all data obtained were tabulated in Microsoft Excel, and descriptive statistics were applied to determine each variable's mean and standard deviation.

Results

Sampling and captures of C. thomsoni

Seventy ichthyofauna sampling points were carried out in the study area; however, specimens of *C. thomsoni* were only obtained in ten of the sampled points, meaning that the species was identified only in 16.6% of the sampled points (n=37) (Table 1).

Table 1. Localization and number of captured specimens

Point	Station	Longitude	Latitude	Altitude (masl)	N
Q2-1	Canana Ravine above (bridge)	-75.0802W	6.7745N	991.8	7
R2	Guadalupe River after download	-75.2296W	6.7937N	1692.4	1
Q3-10	Boquerón Ravine	-75.0584W	7.0292N	363.1	9
Q2-4	Picardía Ravine	-75.1310W	6.7968N	943.0	2
Q2-2	Cancana Ravine	-75.0769W	6.7721N	941.1	7
R4	Porce III Dam (limnim)	-75.1355W	6.9920N	555.6	3
Q3-2	El Saíno Ravine (La Unión)	-75.1742W	6.8989N	700.5	1
QSG	Santa Gertrudis Ravine	-75.2282W	6.7029N	1142.1	4
E15	Grande River (after download-Mocorongo)	-75.3612W	6.5438N	1792.5	2
RG3	Guadalupe River	-75.1897W	6.8388N	806.6	1

The total sampled fish was (n = 37), using specimens sourced exclusively from the Porce River basin. The specimens collected in the Canana, El Boquerón, and Cancana streams contributed 62,16% of the specimens, demonstrating a greater presence of the species in these areas during sampling. An anatomical and histological study of *C. thomsoni* was conducted, including an external description (n = 37) and an internal description (n = 18); the following section outlines our significant findings.

External morphometry

For morphometric description purposes, the animals were separated into groups according to their size and degree of gonadal development (table 2). Two groups were established: juvenile animals measuring less than 70 mm in total length, which did not show gonadal development, and the adult group with sizes greater than 70 mm in total length, which already showed gonadal development. In the juvenile group, the average fresh weight was 2.91 g, eight times less than the average weight of adults (23.01 g), which largely depends on the size of the gonads since the gonadal index in the species is around 10%. The approximate total length of the juveniles was 60.26 mm, corresponding to two-thirds of the size of an adult fish (99.39 mm). The total body width in juveniles averaged 8.30 mm, while in adults, it was almost double, 15.52 mm, which is related to the widening of the body due to gonadal development.

Table 2. External morphometry of *Chaetostoma thomsoni* specimens.

Parameter	Juveniles (n=12) Media ± SD	Adults (n=25) Media ± SD
Live weight (g)	2.91 ± 0.98	23.01 ± 20.58
Fixated specimen weight (g)	3.52 ± 1.13	20.95 ± 18.46
Total length (mm)	60.26 ± 5.95	99.39 ± 20.30
Standard length (mm)	49.44 ± 5.45	84.62 ± 17.83
Total height (mm)	8.30 ± 1.18	15.52 ± 3.85
Number of body plates on dorsal view	23.08 ± 1.24	24.04 ± 1.46
Number of plates between head to dorsal fin	3.67 ± 0.49	3.96 ± 0.20
Number of plates between dorsal and adipose fins	14.33 ± 1.56	13.68 ± 0.95
Number of plates between anal and caudal fins	12.83 ± 0.94	11.88 ± 1.92

To maintain a systematic order, morphometry was carried out by region. In the head region, the dorsal length and width were very similar, showing a symmetry reflected in a square-shaped head (Table 3). Additionally, with the count of odontodes present both in the opercula and cranially to them, it was determined that the number of odontodes present does not only depend on the age or size of the fish since they easily lose them as they are made of dentin. Furthermore, there are odontodes of different sizes in both fish groups studied (juveniles and adults), so it is speculated that they can grow again like the scales made up of dentin do in teleost. The head proportion is directly related to the size of the fish.

Table 3. Morphometry of the head region in specimens of *Chaetostoma thomsoni*

Parameter	Juveniles (n=12) Media ± SD	Adults (n=25) Media ± SD
Dorsal length (mm)	15.29 ± 1.44	25.29 ± 4.63
Dorsal width (mm)	13.59 ± 1.38	25.13 ± 6.44
Ventral length (mm) from opercula to mouth	8.83 ± 1.27	16.65 ± 6.75
Height (mm)	7.30 ± 0.76	13.27 ± 3.65
Head proportion (height/length)	0,47	0,52
Number of odontodes right opercula	4.33 ± 1.61	5.16 ± 1.37
Number of odontodes left opercula	4.08 ± 1.56	4.56 ± 1.56
Number of odontodes cranial to right opercula	2.75 ± 1.14	3.52 ± 1.66
Number of odontodes cranial to left opercula	2.92 ± 1.00	3.92 ± 1.29

In the trunk region, the pectoral and pelvic fins were shown to have the same length in each fish in adults and juveniles. Additionally, morphometry determined that the growth rate of the hard ray in both fins was twice as high in the adult as in the juvenile. In the dorsal fin, it was observed that the length of the hard ray is compared to the height of the fin when it is extended, simulating the shape of an isosceles triangle. The adipose fin was observed to have a hard radius and little quantity and consistency of soft tissue in its macroscopic structure The proportions of the size of the hard rays of the fins, in relation to the size of the trunk, increases in adults, except for the dorsal fin and the adipose fin, which are proportionally more prominent in juveniles (Table 4).

Table 4. External morphometry of the trunk region in *Chaetostoma thomsoni* specimens.

Structure	**Parameter**	**Juveniles (n=12) Media ± SD**	**Adults (n=25) Media ± SD**
Trunk region	Total size (mm)	17.09 ± 2.40	30.12 ± 7.32
Right pectoral fin	Hard fin ray length (mm)	11.44 ± 1.92	22.31 ± 5.86
	Number of hard fin rays	1.00	1.00
	Number of soft fin rays	5.08 ± 0.29	5.4 ± 0.50
	Pectoral fin proportion*	0.66	0.74
Left pectoral fin	Hard fin ray length (mm)	11.80 ± 1.83	23.04 ± 5.73
	Number of hard fin rays	1.00	1.00
	Number of soft fin rays	5.00	5.46 ± 0.59
	Pectoral fin proportion*	0.69	0.76
Dorsal fin	Hard fin ray length (mm)	9.94 ± 1.93	17.08 ± 4.41
	Height (mm)	9.71 ± 1.25	17.53 ± 4.79
	Length (mm)	14.80 ± 2.25	28.56 ± 6.73
	Number of hard fin rays	1.00	1.00
	Number of soft fin rays	7.92 ± 0.29	7.96 ± 0.45
	Dorsal fin proportion*	0.58	0.56
Right pelvic fin	Hard fin ray length (mm)	10.63 ± 1.55	19.56 ± 5.33
	Number of hard fin rays	1.00	0.96 ± 0.20
	Number of soft fin rays	4.42 ± 0.51	4.76 ± 0.83
	Pelvic fin proportion*	0.62	0.64
Left pelvic fin	Hard fin ray length (mm)	10.46 ± 1.83	19.67 ± 4.70
	Number of hard fin rays	1.00	1.00

	Number of soft fin rays	4.42 ± 0.51	4.92 ± 0.28
	Pelvic fin proportion*	0.61	0.65
Adipose fin	Hard fin ray length (mm)	4.11 ± 0.84	6.71 ± 1.54
	Number of hard fin rays	1.00	1.00
	Number of soft fin rays	0.00	0.00
	Adipose fin proportion*	0.24	0.22

*All fin proportions were based on total trunk length in mm.

For the caudal region, the tail fin was observed in a homocercal emarginated shape, with the ventral hard radius larger than the dorsal one, with a difference of approximately 2 mm for juveniles and approximately 4 mm for adults (Table 5).

Table 5. External morphometry of the caudal region in specimens of *Chaetostoma thomsoni.*

Structure	Parameter	Juveniles (n=12) Media ± SD	Adults (n=25) Media ± SD
Caudal region	Total size (mm)	32.45 ± 3.27	56.77 ± 12.17
	Caudal peduncle size	5.44 ± 1.96	8.06 ± 6.42
	Caudal peduncle proportion*	0.16	0.14
Anal fin	Hard fin ray length (mm)	4.96 ± 0.98	7.72 ± 2.22
	Number of hard fin rays	1.00	1.00
	Number of soft fin rays	4.00 ± 0.43	4.04 ± 0.20
Caudal fin	Dorsal hard fin ray length (mm)	10.49 ± 1.79	18.30 ± 5.37
	Ventral hard fin ray length (mm)	12.25 ± 2.92	22.74 ± 6.06
	Number of hard fin rays	2.00	2.00
	Number of soft fin rays	13.33 ± 0.65	14.08 ± 0.57
	Ventral hard fin proportion**	0.24	0.26

*The proportion of the caudal peduncle is calculated in relation to the length of the caudal region, which is from the urogenital pore until the tip of the caudal fin.

**The proportion of the ventral hard of the caudal fin is calculated in relation to the standard length of the body, which is from the tip of the mouth to the caudal peduncle.

Anatomical description of C. thomsoni

Head region

C. thomsoni possesses a wide mouth that remains constantly open, located ventrally, and constituting over 60% of the head region. It features two large lips and bilateral barbels (Figure 2A). The upper lip functions as a mobile and muscular organ, aiding in the displacement of the fish. The lower lip is more extensive, less muscular, and acts as a suction cup with numerous spherical papillae to adhere to the substrate (approximately 53 papillae / cm^2). Under the stereoscope, the teeth of *C thomsoni* are seen as a brush with four regular rows of bristles with which the fish scrapes hard rock surfaces in order to obtain food. No fish were observed with evident tooth loss or irregular spaces between them, showing high resistance to these structures. The teeth exhibit pigmented adaptations at the apex or free edge with a metallic and hard appearance (Figure 2B).

In the rostrodorsal region of the head, the nasal openings, called nares, are identified in a rostromedially position to the eye. They are two small depressions of approximately 2 mm in diameter, partially covered by a mobile membrane that in the center has a small opening that leads a short 1.5 mm channel, which runs in a rostrocaudal direction and ends in a blind sac. Additionally, this membrane completely covers a second channel of equal length, in a caudorostral direction.

Toward the caudal and lateral third of the head were located the eyes, bordered by a dashed line of light spots, with a rostral caudal diameter of 6 mm and a dorsoventral diameter of 5 mm (measured in a single adult individual). The pupil has a crescent moon shape delimited by a punctate light coloration. The eye exhibited movement from dorsal to ventral direction (Figure 2C).

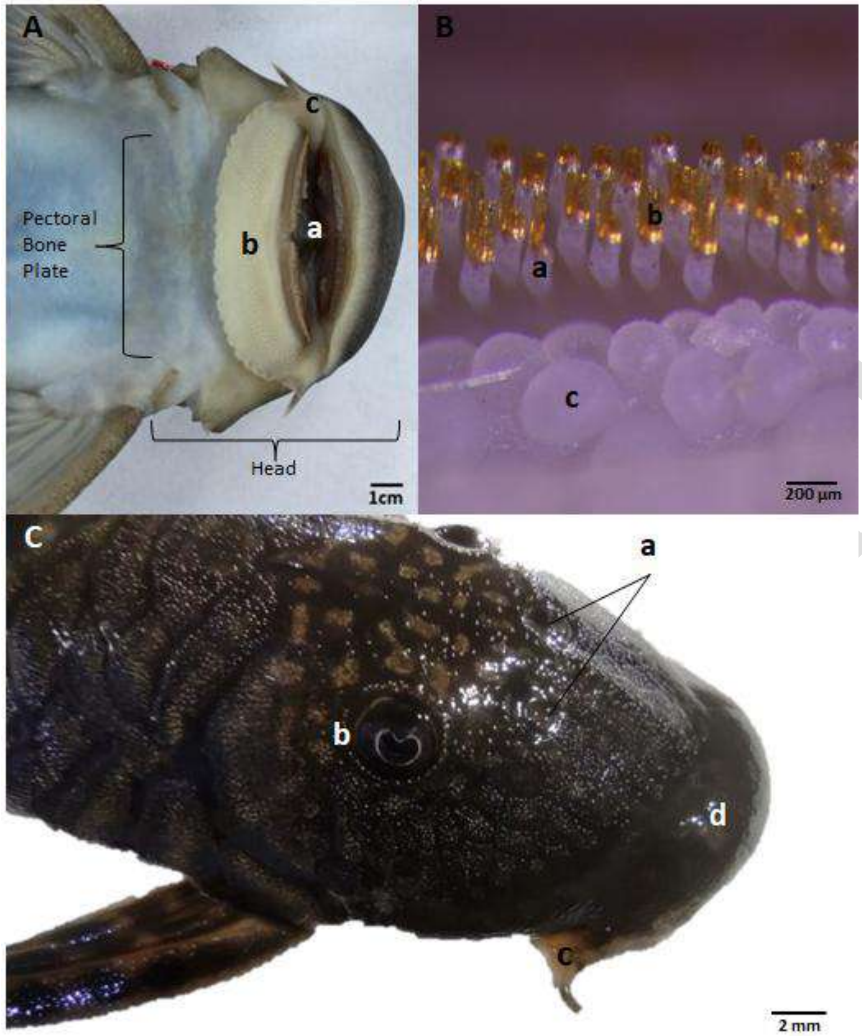

Figure 2. Anatomy of *Chaetostoma thomsoni* head region. A) Ventral view, (a) Oral cavity, (b) Labial sucker cup, and (c) Barbels. B) Mandible, (a) Teeth, (b) Pigmented structures of the teeth, (c) Lip sucker cup papillae. C) Dorsal view, (a) Nares, (b) Eye, (c) Barbels, (d) Upper lip.

Trunk and caudal regions

In both trunk and caudal regions, bony plates with spiny projections were observed on the skin, including on the fins. The fins exhibited pigmented conical structures on the hard fin ray and there were lines of pigment on the soft rays (Figure 3A). In histological sections of the fins, the bony formation of each soft ray was observed, delineated by a line of melanophores and the presence of connective tissue between each ray (Figure 3B). The skin of the dorsal region displayed multiple bony plates with spiny projections oriented craniocaudally (Figure 3C). Histologically, the layers of the skin were observed, where it was evident that the dermal bone was organized into overlapping placodes, and the epidermis is interrupted by conical structures emerging from the bony plate (Figure 3D). These structures correspond to the spiny projections observed macroscopically (Figure 3C).

The epidermis consists of 5 to 7 layers of cells. Goblet cells were observed in the middle layer of the epidermis. Both in the basal and middle layers, cells were arranged in a palisade form with cuboidal cells, and in both layers, the cells were organized perpendicularly. The basal membrane contained abundant diffuse melanin pigment, with a scant dermis and a layer of compact bone in the middle (Figure 3E).

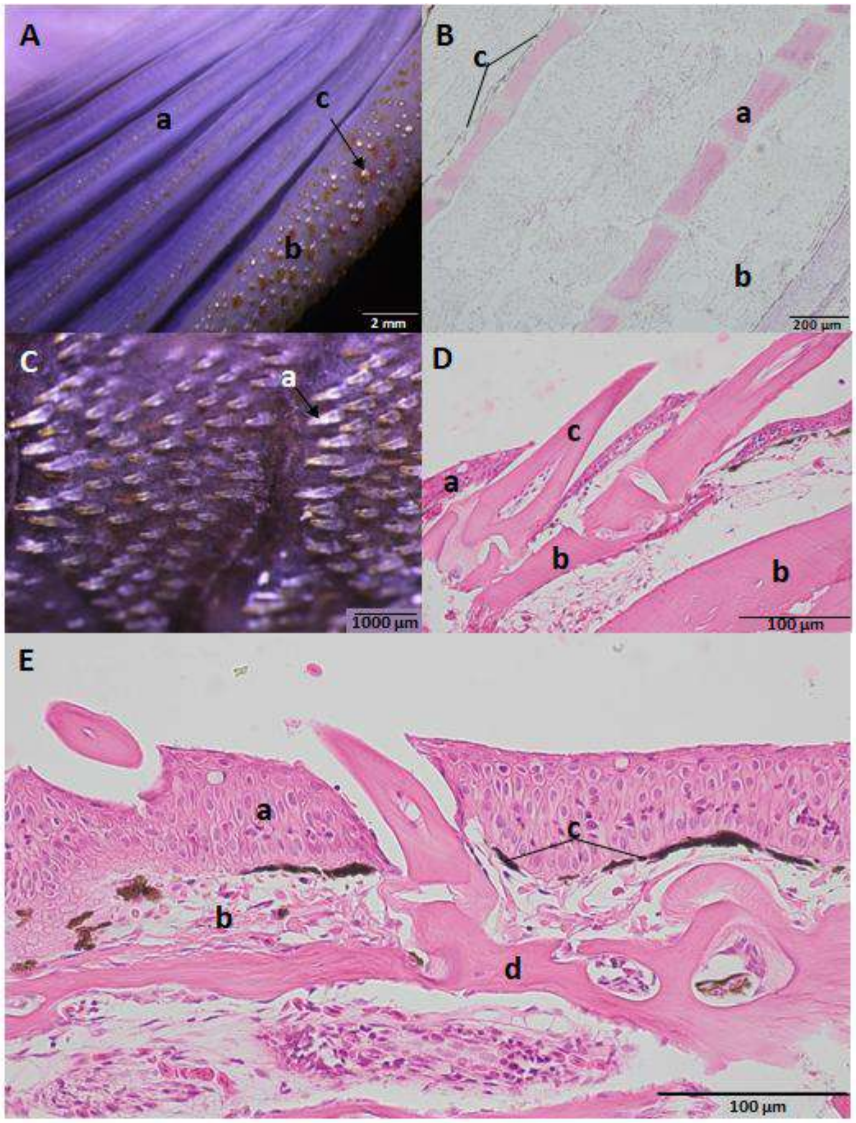

Figure 3. *Chaetostoma thomsoni* fins and dorsal skin of the trunk and caudal region. A) Pectoral fin, (a) Soft ray, (b) Hard ray (spine), (c) Pigmented conical projection. B) Histology of pectoral fin, 10X. (a) Soft ray, (b) Connective tissue, (c) Melanophores. C) Dorsal skin, (a) Spiny projections on the bony plate. D) Histology of dorsal skin, 40X, (a) Epidermis, (b) Cutaneous placodes, (c) Projections emerging from the placodes through the epidermis. E) Histology of dorsal skin, 40X, (a) Epidermis, (b) Dermis, (c) Melanophores, (d) Compact bone. Histological preparations stained with H&E.

Dissection and internal anatomy description

During the dissection process, ventral skin was removed, and the musculature of this area was visualized, where the pectoral, abdominal, and pelvic muscles can be seen (Figure 4A). Upon removing said muscles, the coelomic cavity was accessed, and both pectoral and pelvic bone plates were also evident, articulated with their corresponding fin on each side. Under the pectoral bone plates, the heart was observed inside its pericardial sac, located in the medial part. It was surrounded on both sides by the gills composed of five-gill arches each, which occupy a reduced space within the body cavity. When the arches were separated from the rest of the cavity, a bony sheet was found on each side that wrapped dorsolaterally around the heart, which could be compared to the operculum. The heart showed the ventricle caudally and the atrium in the cranial position (Figure 4C).

Cardiopunction site

In *C. thomsoni*, it is impossible to collect blood as described for other teleost fish due to the ventral position of the operculum, the surrounding bony plates in the cardiac cavity, and the skin bony plates covering the dorsal surface of body fish. Based on the location of the heart, the cardiopuncture site for blood sampling was identified precisely at the ventral median line, caudal to lower lip, and cranial to pectoral bony plate, inserting the needle at an angle of approximately 45º (Figure 4B).

Figure 4. *Chaetostoma thomsoni* dissection of the ventral skin and celomic cavity. A) Exposure of the ventral musculature. (a) Pectoral fins, (b) Pelvic fins, (c) Anal fin, (d) Pectoral musculature, (e) Pelvic musculature, (f) Abdominal musculature, (g) Urogenital and anal pore. B) Location of the anatomical site for cardiac puncture to collect blood samples in the species, the needle is pointing to the ventricle. C) Exposed celomic cavity, ventral view. (a) Heart (ventricle), (b) Gills, (c) Operculum bony plates, (d) Small intestine organized in a spiral around the (e) Hepatopancreas.

Celomic cavity organs

A straight and short esophagus was observed dorsal to the heart between the right and left gill arches, continuing at the level of the body cavity with a well-defined, and U-shaped stomach, almost always empty, located in the right dorsal region of the small intestine. The latter was found caudal to the pectoral bony plate in the caudoventral region, spanning more than 50% of the body cavity, arranged in a spiral with a parenchymal structure of greenish color in its center (Figure 5A), which was histologically determined as hepatopancreas (Figure 5B), as both hepatocytes and pancreatic islets were identified within the same structure. The hepatopancreas presented a multilobed structure with six lobes arranged in the middle of the spiral of the visceral package (Figure 5C), and two additional lobes located in the center of the visceral package both dorsally (Figure 5D) and ventrally (Figure 5E).

The large intestine and rectum were arranged slightly straight towards the urogenital pore. Although the portions of the small intestine were not clearly differentiated, the boundary between the small and large intestine was distinguished, macroscopically and histologically. The coelomic or body cavity presented, as is common in other fish species, a layer of simple and pigmented flat tissue covering the cavity's internal wall, which ends cranial to the urogenital orifice. Additionally, small interwoven fibers of connective tissue supporting adipose panicles within the cavity around the digestive tract organs were identified.

Upon lifting the visceral package, the ligament that holds it to the dorsocranial face of the celomic cavity was observed. In dorsal view of the visceral package, the opening of the esophagus was found in the craniomedial part of the celomic cavity. In the craniodorsal left part, two brown structures were identified, one lateral and triangular, representing the spleen (Figure 5F), and one medial and tongue-shaped, corresponding to another portion of the hepatopancreas. Histologically, differentiation between red pulp and white pulp was observed in the spleen, as well as the presence of the central arteriole (Figure 5G). A ligament connecting these structures in their ventral aspect with the intestinal spiral was found. Within the fat surrounding the caudal part of the greater curvature of the stomach, a lymph node was observed.

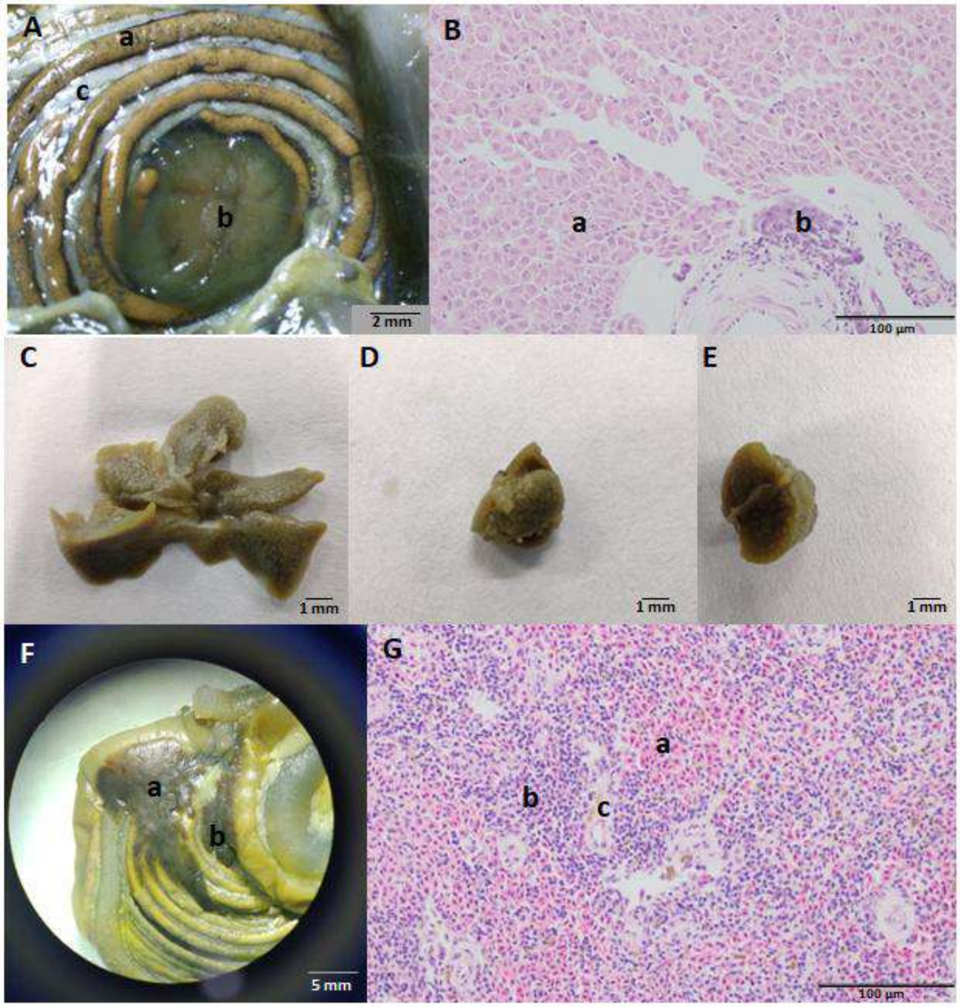

Figure 5. Hepatopancreas and spleen of *Chaetostoma thomsoni*. A) Detail of the small intestine arranged in a spiral around a portion of the hepatopancreas. (a) Small intestine, (b) Hepatopancreas, (c) Adipose tissue. B) Histology of the hepatopancreas, 40X. (a) Hepatocytes, (b) Pancreatic islets. C) Structure of the hepatopancreas, lobes in dorsal view. D) Additional lobe of the hepatopancreas located dorsally. E) Additional lobe of the hepatopancreas located ventrally. F) Stereoscopic image of the spleen in dorsal view. (a) Spleen, (b) Hepatopancreas. G) Histology of the spleen, 40X. (a) Red pulp, (b) White pulp, (c) Central arteriole. Histological preparations stained with H&E.

The stomach exhibited a lesser curvature and a greater curvature, with a translucent appearance in its walls that allowed the observation of gastric content. The first portion of the small intestine, the duodenum, showed the following route: from the pylorus, it extended cranially (ascending duodenum), presented a cranial flexure located dorsocranial to the stomach, and then extended caudally on the left side (descending duodenum). Later, it moved to the right side, in contact with the greater curvature of the stomach, forming a caudal flexure, to progress caudally and begin to form the intestinal spiral, which pursues a counterclockwise direction (Figure 6). The entire intestinal spiral was separated, revealing centripetal loops at the beginning, and then centrifugal loops, presumed to belong to the jejunum and ileum; adipose tissue was observed between each loop. The final part of the spiral is observed as a tube thicker than the rest (large intestine), in a left dorsocaudal direction and caudally it projects medially to end in the rectum.

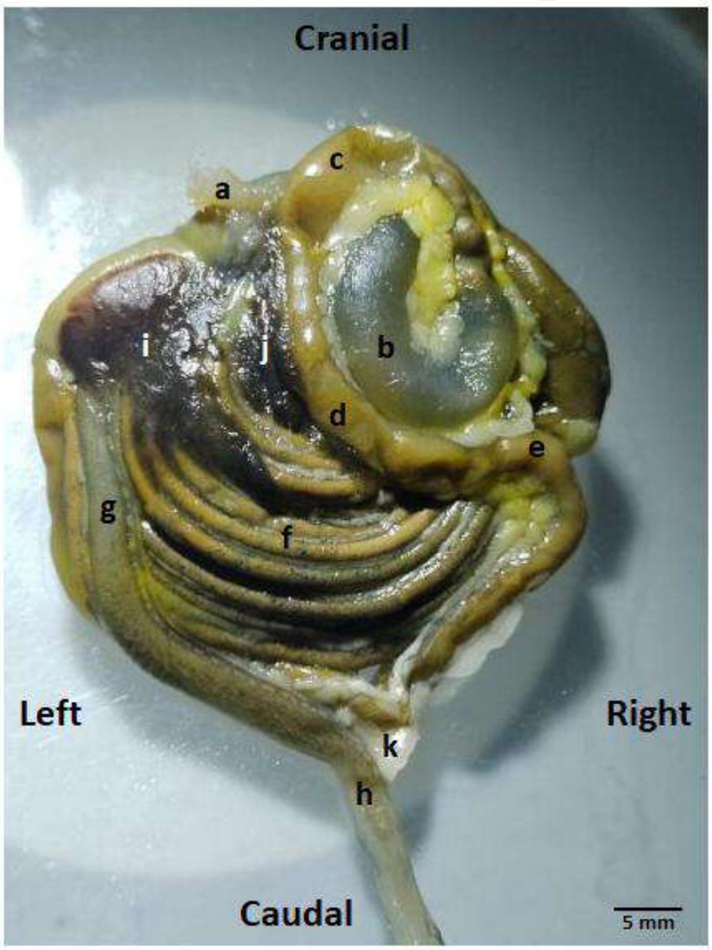

Figure 6. Dorsal view of the viscera in the celomic cavity of *Chaetostoma thomsoni.* (a) Esophagus, (b) Stomach, (c) Cranial flexure of the duodenum, (d) Duodenum, (e) Caudal flexure of the duodenum, (f) Jejunum and ileum, (g) Large intestine, (h) Rectum, (i) Spleen, (j) Hepatopancreas, (k) Surrounding fat.

Gonads

Dorsally to the intestine, the gonads were observed, shaped like a *cul-de-sac*, fused caudally towards the midline at the level of the genital pore. In male specimens, they exhibited a cranial apex with a thickening in their middle third. Two elongated yellowish structures were observed on each side, histologically corresponding to the testicles (Figure 7A). Additionally, towards the middle part, two other structures in the form of translucent whitish blind sacs were observed, which histologically correspond to ureters.

Reproductively active females presented gonads with oocytes distributed in the dorsal part of the celomic cavity (Figure 7B), slightly wider at the trunk level (Figure 7C). Additionally, the suspensory ligament of the ovary (mesovarium) was evident, supporting the gonad along its entire length to the dorsal part of the celomic cavity (Figure 7D), and the interovarian ligament, connecting the gonad to each other at the two-thirds caudal level. Oocytes were classified into three developmental stages: a) oocytes in mature stage three or pre-spawning, with a diameter > 2 mm; b) oocytes in maturation phase two, with a diameter of 1-2 mm; and c) oocytes in maturation phase one, with a diameter < 1 mm (Figure 7E).

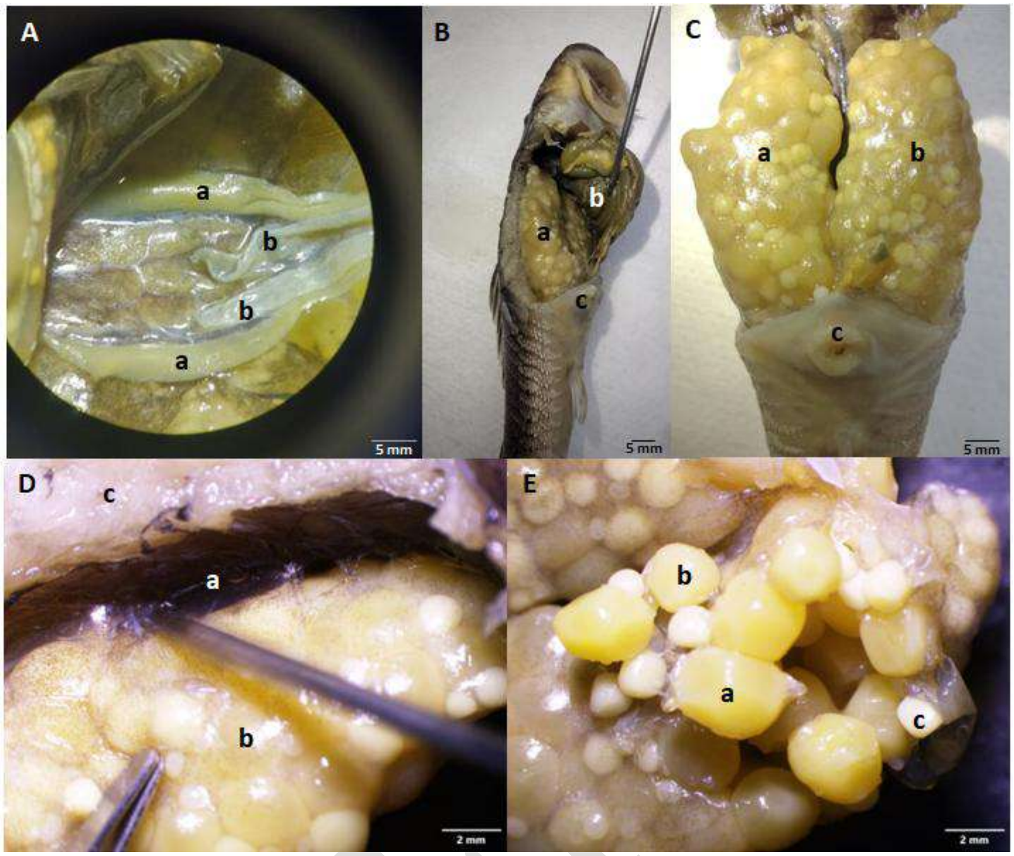

Figure 7. Gonads of *Chaetostoma thomsoni*. A) Genital organs located in the dorsomedial region, towards the middle third of the body cavity. (a) Lateral gonads (testicles), (b) Ureters. B) Female gonads in reproductive phase, right lateral view. (a) Gonads with oocytes, (b) Visceral package, (c) Urogenital pore. C) Ventral view showing the occupation of the gonads within the celomic cavity. (a) Right gonad with oocytes, (b) Left gonad with oocytes, (c) Urogenital pore. D) Lateral view of the gonad. (a) Suspensory ligament of the ovary (mesovarium), (b) Gonad with oocytes, (c) Dorsal wall of the celomic cavity. E) Oocytes at different stages of maturation. (a) Oocyte in maturation stage three, (b) Oocyte in maturation stage two, (c) Oocyte in maturation stage one.

Kidney and urogenital pore

As in other teleost fish in *C thomsoni* the caudal kidney is in the cranial two-thirds of the celomic cavity roof, ventral to the vertebral column. Upon reaching the Stannius corpuscles, the caudal kidney deepens into the tissues that cover the vertebral column ventrally. Laterally to the kidney, the ureters were observed, which cranially formed blind sacs and caudally fused into a urinary bladder, which in turn, opened into the urogenital pore (Figure 8A). A layer of translucent flat tissue covers the kidney, the corpuscles, and the ureters. Histologically, the kidney exhibited abundant interstitial hematopoietic tissue, similar to that described in other fish species (Figure 8B). The cephalic kidney was identified through serial histological cross-sections of the decalcified specimens' skulls. It displayed four lobes separated by bony tissue, two dorsal, and two ventral, the latter being larger. Similar to the caudal kidney, abundant interstitial hematopoietic tissue was observed (Figure 8C).

Finally, during the exploration of the urogenital pore, the presence of two orifices was observed, one cranioventral, leading towards the intestine, and thus considered the anal pore; and another dorsocaudal, which received the gonadal ducts and communicated with the urinary bladder, hence considered the urogenital pore (Figure 8D).

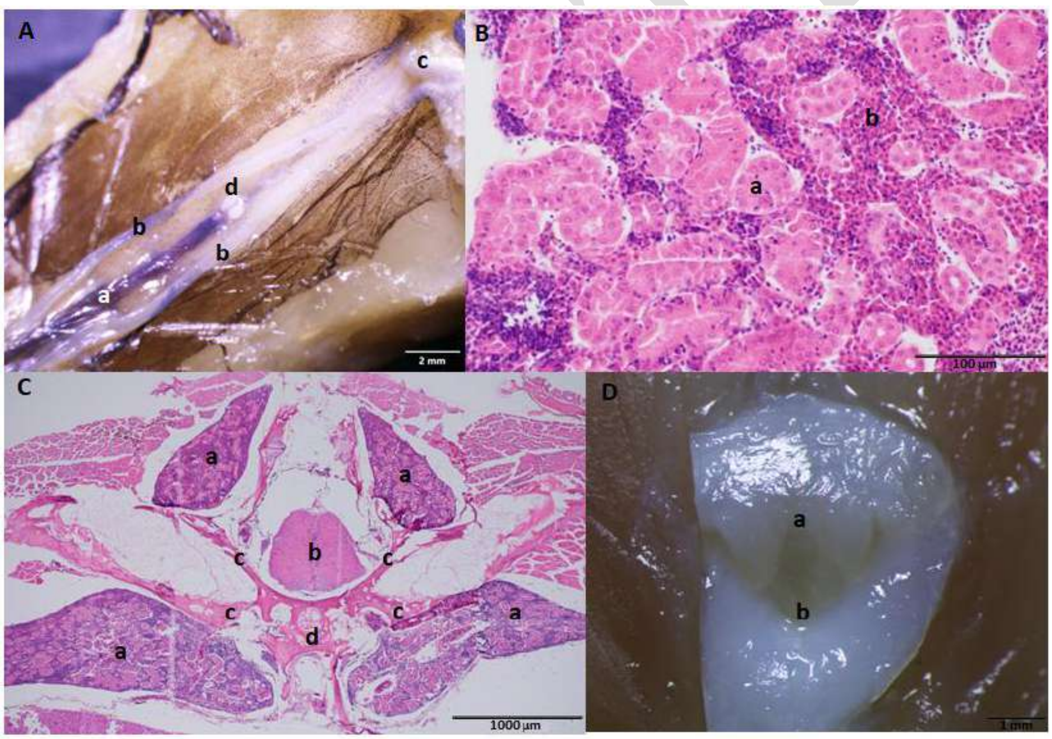

Figure 8. Kidney and urogenital pore of *Chaetostoma thomsoni*, A) Ventral view of the roof of the celomic cavity, (a) Caudal kidney, (b) Ureters, (c) Urinary bladder, (d) Stannius corpuscles. B) Histology of the caudal kidney, 40X, (a) Renal tubules, (b) Interstitial hematopoietic tissue. C) Histology of the cephalic kidney, 4X. (a) Cephalic kidney with interstitial hematopoietic tissue, (b) Brain, (c) Cranial bony tissue, (d) Vertebral bony tissue. D) Ventral view of the pelvic region showing the urogenital pore with two openings, one

related to the digestive system and the other to the urogenital system. (a) Anal pore, (b) Urogenital pore. Histological preparations stained with H&E.

Discussion

In the Porce River basin, two genera and four species of the Loricariidae family have been reported: *Chaetostoma fischeri*, *C. leucomelas*, *C. thomsoni*, and *Lasiancistrus caucanus* (Jiménez-Segura et al., 2014; Restrepo-Santamaria 2022). According to the current study, among the mentioned species, *C. thomsoni* is one of the most abundant species for this genus in the Porce River basin since it was one of the most representative species during the samplings carried out and this is in concordance with other studies made in this area (Restrepo-Santamaria 2022). Consistent with these reports, the present study identified ten distribution points of the species in the Porce River, belonging to the Magdalena River basin, indicating that the species' distribution persists in this area.

This is the first morphological description of *C. thomsoni*, encompassing both internal and external anatomy, as well as the histology of the species. It is noteworthy that, in the absence of similar reports on this species, our discussion will be grounded in findings from studies conducted on other species within the Loricariidae family. This family is one of the most diverse among Neotropical catfishes, also known as silurids (Reis et al., 2003). However, it is crucial to emphasize that the observations made highlight the hardiness of the species, showcasing morphological adaptations that enable its survival in diverse thermal habitats, aligning with existing reports on the Loricariidae family (Favré, 1978).

Fish of the Loricariidae family are characterized by a dorsoventrally flattened body. Additionally, they possess bony plates that completely or partially cover the body. In the former case, the plates cover both the dorsal and ventral aspects of the body, as seen in species like *C. Patiae, C. marginatum*, and *C. leucomelas* (Fowler, 1945; Regan, 1904; Eigenmann, 1918). These plates provide the fish with an armored structure, enabling adaptation and tolerance to habitats with rocky bottoms and swift currents. In the latter case, the plates only cover the dorsal side, leaving the belly protected by a thin layer of skin, usually whitish in color (Maldonado-Ocampo et al., 2005). This arrangement of plates, also exhibited by *C. thomsoni*, is shared by another species in the same genus, *C. anale* (Fowler, 1943), and by other genera within the same family, such as *Ancistrus triradiatus* (Galvis et al., 1997) and *Lasiancistrus caquetae* (Fowler, 1945). This characteristic is considered an adaptation within the Loricariidae family rather than a specific feature of the genus *Chaetostoma.*

According to the genus, there are some differences in the organization of the bony plates, as they may be arranged in two rows of plates, as seen in *Farlowella gracilis* (Regan, 1904), or in more than two rows, as is the case with *Cordylancistrus daguae* (Eigenmann, 1912; Maldonado-Ocampo et al., 2005). In line with the reported literature, the present study identified more than two rows of bony plates in *C. thomsoni*. The number of plates also varies among genera; in *C. thomsoni*, it falls within the range of 24-25 plates, a quantity similar to that described in other *Chaetostoma* species such as *C. marginatum* (Regan, 1904; Eigenmann, 1922), *C. brevilabiatum* (Dahl, 1942), and *C. vagum* (Fowler, 1943). It is also consistent with the number observed in species from other genera, such as *Ancistrus triradiatus* (Galvis et al., 1997). Both the organization and the quantity of bony plates are important morphological characters in the taxonomic determination of species based on external morphology (Maldonado-Ocampo et al., 2005).

The Loricariidae family holds significant importance in the global aquarium trade. Some of these species are widely traded for aquarium purposes in Asian and South American countries, including *Pterygoplichthys punctatus* (spotted pleco), *Leporacanthicus galaxias* (vampire pleco), *Baryancistrus demantoides* (yellow-green pleco), and *C. thomsoni* (pleco or “corroncho”) (INCODER, 2007). These fish are sought after in the aquarium trade due to their distinctive physical appearance, variable colorations, calm behavior, and their role as cleaner fish. Additionally, they are known for their high adaptability and tolerance to environments with elevated concentrations of nitrogen compounds, broad thermal adaptability, rapid growth, easy reproduction, and manageability (Favré, 1978).

Many species of the Loricariidae family are marketed as small fish. However, it is well known that the overall development of fish depends largely on environmental parameters such as water temperature and nutrition. Due to this characteristic, some species, like *C. fischeri* (Ortega-Lara et al., 2006), can reach sizes above 300 mm, and in some cases, they are released into the wild. This makes them introduced fish that can cause ecosystem imbalance due to their voracious behavior and high adaptability to various environments and thermal zones (Favré, 1978). Morphometric reports of *C. thomsoni* captured in the Porce River show sizes ranging from 33 mm to 219 mm (Jiménez-Segura et al., 2014), contrasting with smaller sizes observed in the present study (from 49.59 mm to 144.9 mm). This result may be related to the time of year when they were monitored, as the sampled points were the same. In the first description of *C. thomsoni*, three specimens with a length of 110 mm were recorded captured in Villeta, Cundinamarca, Colombia (Regan, 1904). The genus *Chaetostoma* has shown maximum sizes of up to 300.00 mm in some species, such as *C. leucomelas* (Maldonado-Ocampo et al., 2005) and *C. fischeri* (Ortega-Lara et al., 2006).

Among the most important characteristics of the Loricariidae family are the adaptations of the oral apparatus, which features an oral sucker that may be present only on the lower lip, as in the case of *C. thomsoni* (Regan, 1904), or be on both lips, as observed in *Hypostomus pyrinensi* (Dueñas, 2008). The family also exhibits teeth adapted for hard substrates depending on the genus and, additionally, one or two pairs of barbels located laterally on the upper lip (Favré, 1978). These adaptations enable the fish to adhere strongly to rocky substrates and scrape them to feed on algae or microorganisms present.

It was observed that the number of odontodes does not depend solely on the age or size of the fish, as they are easily lost due to being made of dentin. Furthermore, odontodes were found in different sizes in both juveniles and adults, suggesting that they may regenerate, like scales, also composed of dentin in teleosts, according to a previous report (Sire & Huysseune 1996).

The cardiac puncture is mainly used when caudal vein puncture is not feasible due to the species' anatomical characteristics, such as in fish belonging to the Loriicaridae family, which have their bodies covered by bony plates. To perform the cardiac puncture, the fish is placed in a lateral or ventral position, and the needle is placed in the cardiac ventricle from the lateral angle or ventral to the heart of the fish, with a slight vacuum applied to the syringe. In some species, it is also possible to collect by inserting the needle through the operculum from the base of the gills to the heart (Ranzani et al., 2013, Duman et al., 2018). However, in *C. Thomsoni*, it is impossible to do the cardiopuncture through the operculum because this last part is separated from the cardiac cavity by bone plates. It is essential to highlight that performing a puncture in a vital organ such as the heart carries a greater risk to the fish's health than using blood vessels. This action could result in profuse hemorrhages that can lead to fish death or the generation of areas of tissue damage and even myocardial necrosis (Ranzani et al., 2013).

The study of the digestive system in wild fish species is of paramount importance, as anatomical variations reflect differential ecological resource utilization. Fish from the Loricariidae family play a significant role in the energy recycling of neotropical aquatic ecosystems (Pessoa et al., 2013). Fish that consume fine-grain detritus possess rudimentary labial and pharyngeal teeth, thin stomach walls, and long intestines, as reported for the species *Rhinelepsis aspera* (Delariva & Agostino, 2001), which aligns with our findings for *C. thomsoni*. These authors report other Loricariidae family species that consume coarser food (periphyton); therefore, they have longer and stronger teeth, a more developed stomach, and a shorter intestine, such as *Megalancistrus aculeatus* and *Hypostomus microstomus.* There are also species with intermediate characteristics, such as *H. regani, H. ternetzi*, and *H. margaritifer* (Delariva & Agostino, 2001).

The stomach of Loricariidae exhibits similar characteristics among species. Several authors attribute respiratory functions to the stomach, in addition to digestive functions (Pessoa et al., 2013; Delariva & Agostino, 2001; de Oliveira et al., 2001; da Cruz et al., 2009). According to Armbruster (1998), Loricariid catfishes have evolved modifications of the digestive tract that function as accessory or hydrostatic organs, such as an enlarged, clear, air-filled stomach, a U-shaped or ring-like diverticula that are similar to swim bladders and may be used as hydrostatic organs (Armbruster, 1998). In some species, the ability to breathe air in the stomach was confirmed (de Oliveira et al., 2001). For *Chaetostoma*, a slight ability to breathe air under hypoxia has been reported. The stomach is an excellent structure for breathing because of its connection with the outside of the body and its high vascularization (Armbruster, 1998). Given that the findings in *C. thomsoni* were similar to those reported previously, it is highly probable that this species has this dual function in the stomach, especially considering its lack of a swim bladder.

There are reports of the presence of a quite long, spiral-shaped intestine in other species of the Loricariidae family, such as *Hypostomus pusarum* (Pessoa et al., 2013), *Rhinelepsis aspera, Megalancistrus aculeatus, Hypostomus microstomus, H. regani, H. ternetzi*, and *H. margaritifer* (Delariva & Agostino, 2001). This finding is similar to what was observed in the present study for *C. thomsoni*. A long intestine is in line with the type of algivorous and detritivorous feeding, which is abundant but difficult to digest and has low nutritional value (Pessoa et al., 2013; Delariva & Agostino, 2001).

For several species of loricariids, the presence of the liver in the center of the intestinal spiral was reported (Pessoa et al., 2013; Delariva & Agostino, 2001). However, the histological evaluation conducted in the present study for *C. thomsoni* revealed that this structure is the hepatopancreas. Further histological studies in other loricariid species will be necessary to confirm if this is the case for other species as well.

Regarding the ovaries, it is remarkable the large size of the eggs found in some specimens of *C. thomsoni*, characteristic also found in other species of Loricariid such as *Lithoxus*, with mature eggs as big as 2.2 mm, proportionally very big for the small size of the fish (41.4 mm) (Armbruster, 1998). *C. thomsoni* presents a synchronous development of multiple groups or asynchronous development, which refers to species with more than one group of developing oocytes and is characteristic of species that spawn several times within the same spawning season (tropical fish) (Sierra-de la Rosa, 2007). In the present study, the maturation stage of oocytes was classified into three developmental stages: in maturation phase one (< 1 mm); in maturation phase two (1-2 mm); and mature stage three or pre-spawning (> 2 mm); similar to reported by other studies for this specie, which reported smaller diameter like 0.6 mm, and the largest diameter in mature oocytes as 3.8 mm (Loaiza et al., 2018).

One of the most significant findings of the present study is the shape of the cranial kidney of *C. thomsoni*, which exhibits a bifurcated arrangement cranially, partially enveloping the brain. The cranial part of the kidneys, as identified in this study, was found to have hemolymphopoietic, endocrine, and immunological functions, consistent with the characteristics described for most fish (Plaul et al., 2012). However, the presence of this structure had not been previously described in fish of the Loricariidae family.

In general terms, the native ichthyofauna of the Porce River basin has been poorly described both morphologically and histologically. The development of new knowledge from these species will allow for a better ecological understanding and improved management during monitoring. Additionally, establishing a baseline in the study of internal organs, some of which were described for the first time, will enable the recognition and determination of the health status of fish in future samplings. Hematological and hepatic findings, as well as the evaluation of gills, among other factors, contribute to the study of the health conditions of fish in various sampled environments, including reservoirs, rivers, and streams. This, in turn, facilitates future research on the adaptive processes of ichthyofauna to the changing conditions of an intervened environment. Furthermore, these studies provide tools for decision-making regarding the implementation of programs aimed at the conservation and proper management of ichthyofauna to mitigate negative impacts on biodiversity.

Declarations

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Conflict of Interest

The authors declare that there is no conflict of interest related to this work.

Author Contributions

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Use of artificial intelligence (AI)

The authors declare that they have not used artificial intelligence to draft the manuscript.

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