



A new species of *Trichomycterus* (Siluriformes: Trichomycteridae) from the upper río Magdalena basin, Colombia

LUIS J. GARCÍA-MELO¹, FRANCISCO A. VILLA-NAVARRO¹ & CARLOS DONASCIMIENTO^{2,3}

¹Grupo de Investigación en Zoología, Facultad de Ciencias, Universidad del Tolima, Colombia.

E-mail: luchojgm@gmail.com, favilla@ut.edu.co

²Instituto de Investigación de Recursos Biológicos Alexander von Humboldt, Villa de Leyva, Colombia.

E-mail: cdonascimento@humboldt.org.co

³Corresponding author

Abstract

Trichomycterus tetuanensis, new species, is described from the río Tetuan, upper río Magdalena basin in Colombia. The new species is distinguished by its margin of caudal fin conspicuously emarginate, in combination with a high number of opercular odontodes (21–39), reflected externally in the correspondingly large size of the opercular patch of odontodes, 3 irregular rows of conic teeth in the upper jaw, 42–52 interopercular odontodes, 8 branchiostegal rays, 37 post Weberian vertebrae, 7 branched pectoral-fin rays, hypural 3 separated from hypural plate 4+5, and background coloration light brown with darker dots uniformly sparse on dorsum and sides of trunk. Some apomorphic characters informative for the phylogenetic affinities of the new species within *Trichomycterus* are discussed.

Key words: catfishes, Neotropics, systematics, taxonomy, Trichomycterinae

Resumen

Trichomycterus tetuanensis, especie nueva, es descrita para el río Tetuan, cuenca alta del río Magdalena. La especie nueva es diferenciada por su margen de la aleta caudal conspicuamente emarginado, en combinación con un elevado número de odontodes operculares (21–39), reflejado externamente en el correspondientemente gran tamaño del parche de odontodes operculares, 3 hileras irregulares de dientes cónicos en la mandíbula superior, 42–52 odontodes interoperculares, 8 radios branquiostegios, 37 vértebras post Weberianas, 7 radios ramificados en la aleta pectoral, hipural 3 separado de la placa hipural 4+5 y coloración de fondo marrón claro con puntos más oscuros uniformemente dispersos sobre el dorso y los costados. Algunos caracteres apomórficos informativos sobre las afinidades filogenéticas de la especie nueva dentro de *Trichomycterus* son discutidos.

Introduction

The Trichomycteridae includes small to medium size catfishes (ranging from less than 20 mm to 500 mm SL) that are widely distributed on both sides of the Andes in South America, extending south to Patagonia and north to Costa Rica in Central America (de Pinna & Wosiacki, 2003). The family contains 283 species and 41 valid genera (Eschmeyer & Fong, 2016), currently grouped in nine subfamilies (de Pinna, 1998).

Trichomycterus is the most diverse genus of its family, including more than half of its known species, but at the same time its non-monophyletic status (Baskin, 1973; de Pinna, 1989; Dutra *et al.*, 2012) represents one of the most challenging subjects in the systematics of the Neotropical ichthyofauna. The genus is still defined by a traditional precladistic concept (Eigenmann, 1918; Myers, 1944; Tchernavin, 1944) that allows the inclusion of all generalized trichomycterines that do not fit into the remaining genera, which are mostly monotypic and defined by autapomorphies. On the other hand, the taxonomic diversity of *Trichomycterus* is noteworthy, given the apparently high endemism of the numerous populations found in the headwaters and small streams of river systems

(Fernández & Vari, 2009, 2012; Ferrer & Malabarba, 2013; DoNascimento *et al.*, 2014b). However, while the high taxonomic diversity of *Trichomycterus* is unquestionable, it is also true that its actual diversity is obscured by many early and even recent descriptions of slightly-differentiated populations that do not account for intraspecific variation (e.g. color pattern and meristics). These taxonomic works are characterized by ambiguous diagnoses, vague descriptions, and limited taxonomic comparisons that in the best case are restricted to the most geographically proximal species, with little concern for already named similar species. Thus the bulk of these contributions results in a scenario of ever-growing nomenclatural confusion.

The present paper describes a new species of *Trichomycterus* from a tributary of the upper río Magdalena basin in Colombia, representing the sixteenth species recorded from this trans-Andean basin, which concentrates the highest diversity of the genus in Colombia.

Materials and methods

All measurements were taken point-to-point with digital calipers on the left side of specimens to the nearest 0.1 mm. Measurements followed de Pinna (1992), with the addition of: 1) length of first pectoral-fin ray, 2) length of second pectoral-fin ray, 3) eye diameter (horizontal length of eye), and 4) interopercular patch length (taken from base of anterior most odontode to distal tip of posterior most odontodes). Cleared and counterstained (cs) specimens for cartilage and bone were prepared according to Taylor & Van Dyke (1985). Vertebral counts did not include those in the Weberian complex and the compound caudal centrum was counted as one element. Counts of interopercular odontodes, pharyngeal teeth, branchiostegal rays, vertebrae, ribs, fin rays, and number and position of supporting elements of dorsal and anal fins were done in cs specimens only. Number of opercular odontodes was determined in all available specimens. Counts of odontodes in cs specimens included all odontodes directly attached to the bone, plus the empty sockets corresponding to detached odontodes. Dorsal and anal-fin ray counts included all unbranched rays. Counts for the holotype for meristic characters that varied are indicated by an asterisk or enclosed in parentheses. The nomenclature for sensory pores of supraorbital and infraorbital canals followed Arratia & Huaquin (1995), and for postotic branches followed Schaefer & Aquino (2000). Morphological data for *Trichomycterus argos* Lezama, Triques & Santos, *T. boylei* (Nichols), *T. brunoi* Barbosa & Costa, *T. caipora* Lima, Lazzarotto & Costa, *T. duellmani* Arratia & Menu-Marque, *T. giganteus* Lima & Costa, *T. hualco* Fernández & Vari, *T. jacupiranga* Wosiacki & Oyakawa, *T. maracaya* Bockmann & Sazima, *T. megantoni* Fernández & Chuquihamaní, *T. mimosensis* Barbosa, *T. minus* Fernández & Vari, *T. nigricans* Valenciennes, *T. papilliferus* Wosiacki & Garavello, *T. plumbeus* Wosiacki & Garavello, *T. rubbioli* Bichuette & Rizzato, *T. sandovali* Ardila Rodríguez, *T. santanderensis* Castellanos-Morales, *T. therma* Fernández & Miranda, *T. tupinamba* Wosiacki & Oyakawa, and *T. yuska* Fernández & Schaefer were obtained from their respective original descriptions and redescriptions (*T. boylei*: Arratia & Menu Marque, 1984; *T. nigricans*: Arratia, 1998). Institutional abbreviations follow Sabaj Pérez (2014).

Comparative material: additional material is listed in DoNascimento (2015) and DoNascimento *et al.* (2014a, b). *Eremophilus mutisii* Humboldt: Colombia: Cundinamarca: MPUJ 2528 (1 cs), Guatavita, embalse de Tominé, Vereda Chaleche, Club Náutico Refugio de Tominé, 04°59'10.7"N 73°49'09"W, 2622 m asl. *Trichomycterus banneai* (Eigenmann): Colombia: Tolima: upper río Magdalena basin: CZUT-IC 1270 (20; 4 cs), quebrada Bernal, Honda. *Trichomycterus bogotensis* (Eigenmann): Colombia: Cundinamarca: río Magdalena basin: ICN-MHN 567 (1), Usme, río Chisacá, 3300 m; ICN-MHN 759 (1 cs), quebrada de Soacha, sabana de Bogotá. *Trichomycterus caliensis* (Eigenmann): Colombia: Valle del Cauca: upper río Cauca basin: IMCN 4284 (5), 4286 (4 cs), Cali, río Cali. *Trichomycterus chapmani* (Eigenmann): Colombia: Quindío: upper río Cauca basin: IMCN 4283 (18), 4285 (5 cs), Armenia, río Quindío, in the road to Salento. *Trichomycterus stellatus* (Eigenmann): Colombia: Cundinamarca: upper río Magdalena basin: CZUT-IC 2971 (29), 2972 (2 cs), Guaduas, quebrada Sarjento. *Trichomycterus torcoromaensis* Ardila Rodríguez: Colombia: Norte de Santander: río Magdalena basin: IAvH-P 13422 (5), Ocaña, quebrada Torcoroma. *Trichomycterus transandianus* (Steindachner): Colombia: Tolima: upper río Magdalena basin: CZUT-IC 468 (2), CZUT-IC 471 (3), CZUT-IC 475 (2), CZUT-IC 1197 (1, 1 cs), CZUT-IC 1198 (1, 1 cs), CZUT-IC 1199 (1), CZUT-IC 1312 (1), CZUT-IC 3139 (3, 1 cs), Ibagué, quebrada El Gallo, vereda El Gallo. *Trichomycterus* sp. 1: Colombia: Tolima: upper río Magdalena basin: CZUT-IC 512 (20; 2 cs), Rovira, quebrada Andes, vereda Martínez. *Trichomycterus* sp. 3: Colombia: Huila: upper río Magdalena basin: CZUT-IC

3011 (16; 2 cs), Yaguará, quebrada El Viso. *Trichomycterus* sp. 4. Colombia: Huila: upper río Magdalena basin: CZUT-IC 3017 (18; 2 cs), Yaguará, río Yaguará. *Trichomycterus* sp. 5. Colombia: Huila: upper río Magdalena basin: CZUT-IC 2382 (2), San Agustín, río Guarapas; IAvH-P 7075 (3; 2 cs), IAvH-P 7073 (2; 1 cs). *Trichomycterus* sp. Colombia: Huila: upper río Magdalena basin: CAR 130 (3, 2 cs), San Agustín, creek between veredas Quebradillas and Arauca.

***Trichomycterus tetuanensis*, new species**

(Figs. 1–3, Table 1)

Trichomycterus striatus (non Meek & Hildebrand, 1913): Maldonado-Ocampo *et al.*, 2005: 112 [description, listing of cataloged specimens].

Holotype. CZUT-IC 5151 (57.2 mm SL), Colombia, Tolima, Ortega, río Tetuán, upper río Magdalena basin, 03°51'23.866"N 75°16'47.508"W, elevation 374 m, 6 Jun 2003, A. Ortega-Lara, F. A. Villa-Navarro and J. García-Melo.

Paratypes. CZUT-IC 883 (5, 62.6–96.1 mm), Colombia, Tolima, Ortega, río Peralonso, 03°52'16.074"N 75°16'21.51"W, elevation 383 m, 7 Jun 2003, A. Ortega-Lara, F. A. Villa-Navarro and J. García-Melo; CZUT-IC 904 (9, 43.1–78.6 mm SL; 2 cs, 47.4–50.9 mm SL), IAvH-P 12753 (1, 67.6 mm SL; 1 cs, 63.5 mm SL), collected with the holotype; CZUT-IC 896 (7, 59.7–82.7 mm SL), same locality and collectors as holotype, 5 Oct 2003.



FIGURE 1. Holotype of *Trichomycterus tetuanensis*, CZUT-IC 5151, 57.2 mm SL; Colombia, Tolima, Ortega, río Tetuán, upper río Magdalena basin, 03°51'23.866"N 75°16'47.508"W (scale bar = 1 cm).

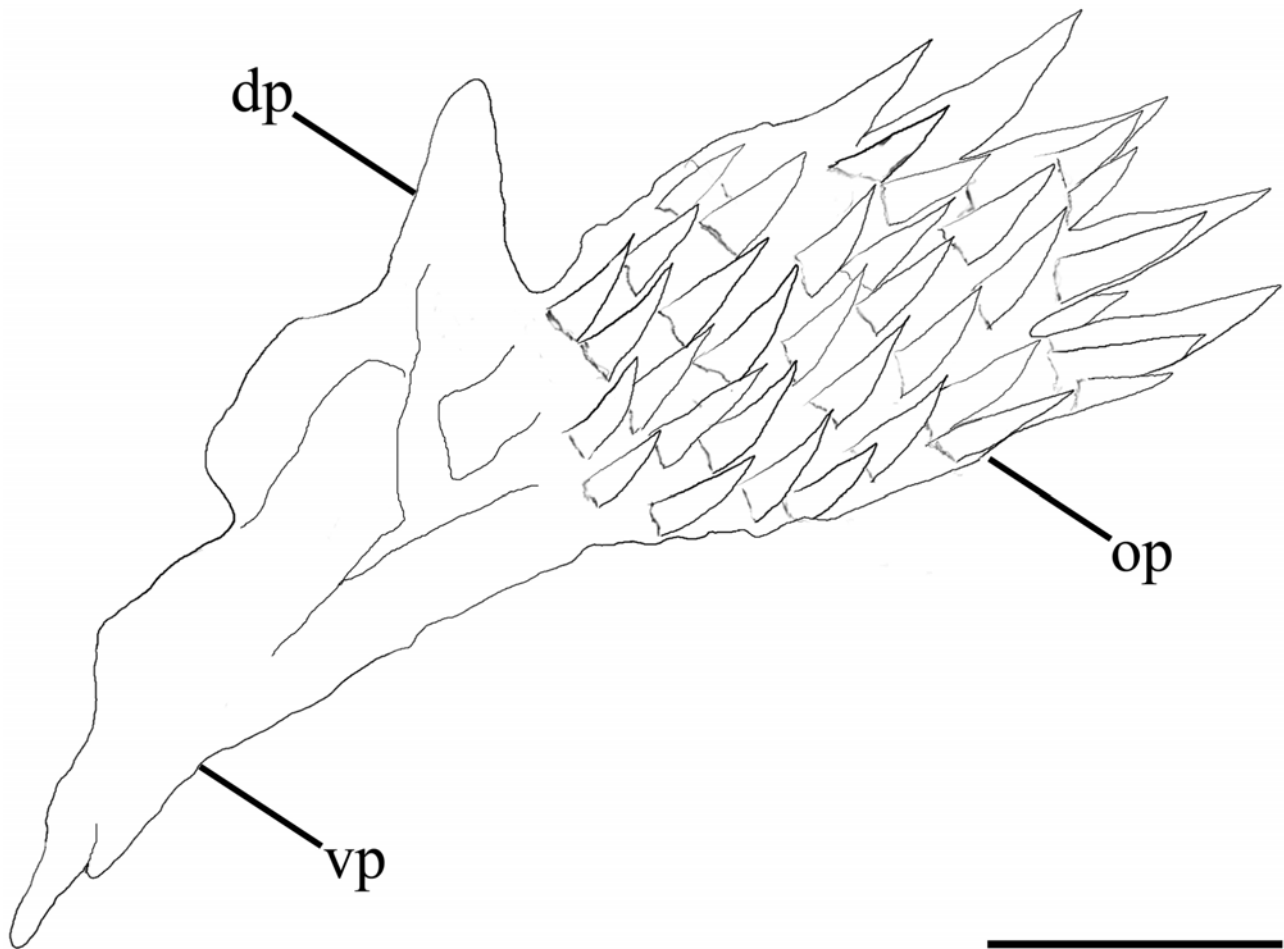


FIGURE 2. Left opercle (lateral view, anterior to the left) of *Trichomycterus tetuanensis*, paratype, CZUT-IC 904, 50.9 mm SL. Abbreviations: dp, dorsal process; op, opercular plate of odontodes; vp, ventral process (scale bar = 1 mm).



FIGURE 3. Live paratype of *Trichomycterus tetuanensis*, CZUT-IC 904, Colombia, Tolima, Ortega, río Tetuán, upper río Magdalena basin, 03°51'23.866"N 75°16'47.508"W (photo by J. E. García-Melo).

Diagnosis. *Trichomycterus tetuanensis* is distinguished from most congeners by its emarginate caudal fin (Fig. 1), which, with the single exception of *Trichomycterus banneai*, is either round or truncate in the remaining trans-Andean species from Colombia. *Trichomycterus tetuanensis* differs from *T. banneai* in its larger size (96.1 mm SL vs. 44.0 mm SL), pigmentation pattern (background light brown with darker dots smaller than eye diameter, uniformly sparse on dorsum and sides of trunk vs. background yellow with predorsal and horizontal mid-lateral rows of large blotches), higher number of premaxillary teeth rows (three vs. two), higher number of branchiostegal rays (eight vs. seven), higher number of free vertebrae (37 vs. 34), and hypural 3 separated from hypural plate 4+5

(vs. fused). The new species is additionally distinguished from most of its congeners by its high number of opercular odontodes (21–39 vs. 30 or less odontodes), arranged in 6–8 dorsoventral transverse rows, and evident as an externally conspicuous large opercular patch of odontodes (Fig. 2).

Description. Morphometric data presented in Table 1. Body elongated, deeper than wide in trunk region, gradually compressed to caudal-fin base (Figs. 1, 3). Dorsal profile of head straight; trunk slightly convex just posterior to head to dorsal-fin origin; straight to slightly concave along dorsal-fin base; anterior region of caudal peduncle straight, sloping dorsally along most anterior part of caudal fin. Ventral profile of head straight to slightly convex; trunk slightly concave to straight at pectoral-fin insertion; straight to slightly convex just posterior to this point to pelvic-fin base; straight and sloping dorsally to anal-fin origin; anterior region of caudal peduncle concave, then continuing as a ventrally sloping straight line along most anterior part of caudal fin. Cross-section of body approximately oval at pectoral-fin base.

TABLE 1. Morphometric data for holotype and nine paratypes of *Trichomyterus tetuanensis*. Measurements 2–13 expressed as percentage of standard length and 14–23 as percentage of head length. x = arithmetic mean, R = range, and SD = standard deviation.

	Holotype	x	R	SD
1. Standard length	57.2	–	43.3–96.1	–
2. Total length	117.0	116.2	112.6–118.5	–
3. Body depth	14.5	14.4	12.2–15.8	0.9
4. First pectoral-fin ray	21.2	17.8	8.4–23.0	2.9
5. Second pectoral-fin ray	14.3	13.2	11.5–15.2	0.9
6. Predorsal length	67.8	67.4	65.5–69.8	1.0
7. Preanal length	73.1	74.2	72.5–76.3	1.1
8. Prepelvic length	58.7	58.3	56.2–60.0	1.2
9. Dorsal fin base	12.6	11.4	10.3–12.7	0.7
10. Anal fin base	7.9	7.7	7.0–8.8	0.5
11. Caudal-peduncle length	17.1	18.1	16.4–20.2	0.9
12. Caudal-peduncle depth	9.8	10.8	8.7–11.8	0.7
13. Head length	19.4	19.0	17.4–20.2	0.7
14. Head width	86.5	83.0	75.7–91.5	4.1
15. Head depth	42.3	43.5	33.2–55.6	5.7
16. Snout length	42.3	41.8	38.5–45.4	1.7
17. Mouth width	36.9	34.2	28.7–39.6	2.9
18. Interorbital distance	27.0	26.1	22.4–29.5	2.3
19. Eye diameter	8.1	7.7	6.7–8.7	0.6
20. Maxillary barbel length	95.5	79.3	51.7–95.8	13.2
21. Nasal barbel length	84.7	66.2	46.1–86.3	12.1
22. Rictal barbel length	76.6	61.3	37.4–76.6	11.7
23. Interopercular patch length	35.1	33.5	30.2–37.6	2.1

Head depressed, longer than wide, triangular in dorsal view. Cheek muscles slightly bulging externally in lateral contour of head. Eye small, dorsolateral on middle of head. Eye rim not free, covered by thin and translucent skin, continuous with head skin. Mouth subterminal, relatively narrow. Upper lip with minute papillae immediately anterior to premaxillary teeth. Lower lip with large rectangular lateral lobes located posteromedially to rictal barbel base. Premaxillary teeth conical, arranged in three irregular rows. Dentary teeth conical, similar in size to those of premaxilla, arranged in three irregular rows near symphysis and one row to posterior region of dentary. Anterior nostril medially surrounded by fleshy flap, increasingly deeper posteriorly and laterally continuous with nasal barbel. Posterior nostril closer to anterior nostril than to eye; anterior rim delimited by thin fleshy elevated margin;

posterior rim not delimited by fleshy flap, and continuous with head surface. Barbels long and flattened, tapering distally. Nasal barbel originating laterally from fleshy fold encircling anterior nostril and extending posteriorly to half-length of opercular patch of odontodes. Tip of maxillary barbel surpassing pectoral-fin base. Rictal barbel slightly shorter than maxillary barbel, with its tip reaching posterior region of pectoral-fin base. Interopercle with 42–52 odontodes, arranged in three irregular rows. Posterior interopercular odontodes of medial row largest, with distal tip medially curved. Opercular patch of odontodes large and almost circular in shape, with 21–39 conic odontodes arranged in 6–8 dorsoventral transverse rows. Opercular odontodes gradually larger posteriorly. Branchiostegal membrane supported by eight rays and joined to isthmus only anteriorly, forming a narrow free fold across isthmus. Medial most three branchiostegal rays associated with anterior ceratohyal, next three rays with interceratohyal cartilage and lateral most two rays with posterior ceratohyal. Branchiostegal rays 5–8 expanded distally (Fig. 4), branchiostegal ray 6 with greatest distal expansion (four times as wide as distal tip of ray 7). Gill opening wide.

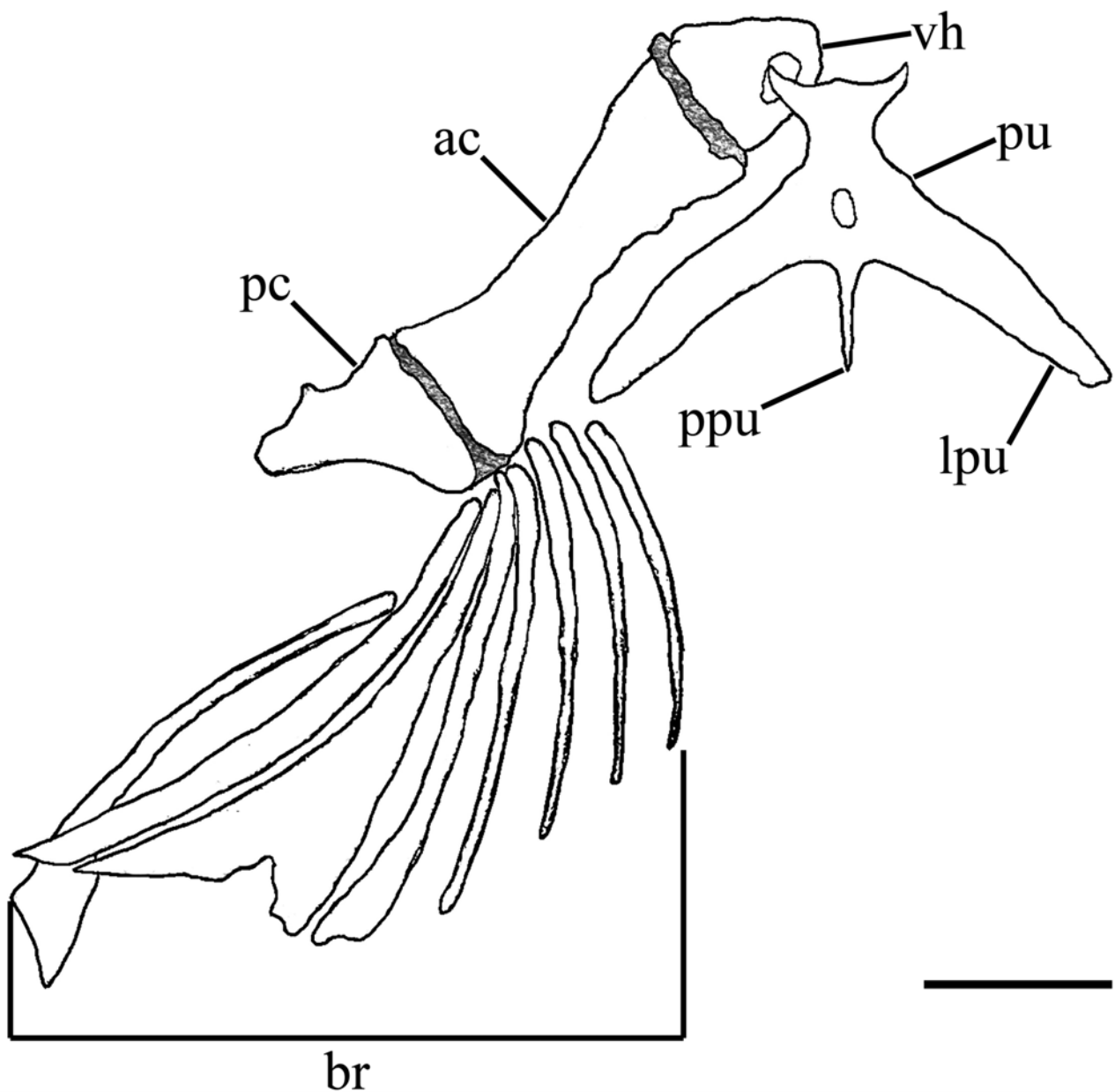


FIGURE 4. Dorsal view (anterior to top) of hyoid arch of left side of *Trichomycterus tetuanensis*, paratype, CZUT-IC 904, 50.9 mm SL. Abbreviations: ac, anterior ceratohyal; br, branchiostegal rays; lpu, lateral process of parurohyal; pc, posterior ceratohyal; pu, parurohyal; ppu, posterior process of parurohyal; vh, ventral hypohyal (scale bar = 1 mm).

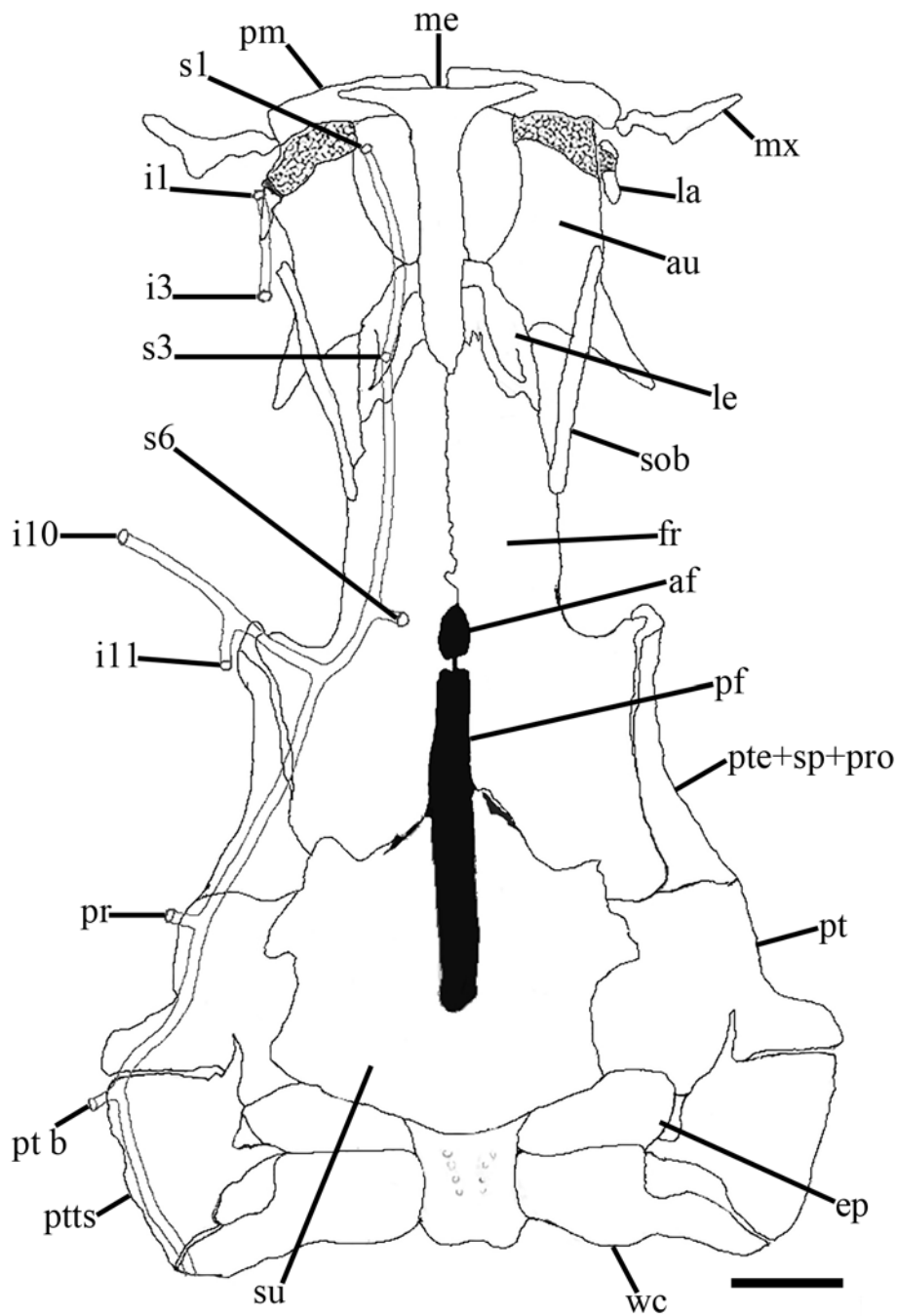


FIGURE 5. Dorsal view of cranium and Weberian capsule of *Trichomycterus tetuanensis*, paratype, CZUT-IC 904, 50.9 mm SL. Abbreviations: af, anterior fontanel; au, autopalatine; ep, epioccipital; fr, frontal; i1, i3, i10-11, infraorbital sensory pores 1, 3, and 10–11; la, lachrymal/antorbital; le, lateral ethmoid; me, mesethmoid; mx, maxilla; pf, posterior fontanel; pm, premaxilla; pr, sensory pore of preopercular canal; pt, pterotic; pt b, sensory pore of pterotic branch; pte+sp+pro, pterosphenoid+sphenotic+prootic compound bone; ptt, posttemporo-supracleithrum; sob, sesamoid supraorbital; su, parieto-supraoccipital; s1, s3, s6, supraorbital sensory pores 1, 3, and 6; wc, Weberian capsule (scale bar = 1 mm).

Anterior margin of mesethmoid straight (Fig. 5). Anterior fontanel small, oval (*ca.* 15% of posterior fontanel length). Epiphyseal bar entirely osseous, not meeting medially. Posterior fontanel long, rectangular, extending from epiphyseal bar to approximately last third of parieto-supraoccipital. Lachrymal/antorbital associated with anterior section of infraorbital canal (sensory pores i1 and i3). Sesamoid supraorbital long (*ca.* four times longer than lachrymal/antorbital), lacking lateral processes. Anterior portion of sphenotic anterolaterally directed. Vomer arrow-shaped with a pair of short processes posterolaterally directed. Parasphenoid with long posterior process that reaches anterior region of basi-exoccipital. Basi-exoccipital with a pair of short anterior membranous processes,

laterally adjacent to posterior process of parasphenoid. Premaxillary bone rectangular and relatively short. Autopalatine with medial margin concave and posterolateral process long and pointed. Metapterygoid small, triangular. Hyomandibula with well-developed anterodorsal membranous outgrowth, its dorsal margin smooth and concave along anterior region. Basibranchials 2 and 3 and hypobranchial 1 rod-like of similar length. Basibranchial 2 wider than basibranchial 3. Basibranchial 4 cartilaginous hexagonal plate. Hypobranchial 1 slightly concave along posterior margin, lacking processes. Ossified portion of hypobranchial 2 approximately triangular and anterolaterally oriented, representing *ca.* 40% of entire hypobranchial. Hypobranchial 3 trapezoidal, with triangular ossified portion anterolaterally oriented, representing *ca.* 10% of entire hypobranchial. Ceratobranchial 5 with 18–22 conical teeth aligned in three irregular rows along anteromedial margin of bone, increasing in size medially. Epibranchial 1 with long anterior uncinat process anterolaterally directed and short posterior process at distal region. Epibranchial 2 with anterior uncinat process (*ca.* 40% of length of anterior uncinat process of epibranchial 1) and short triangular posterior process at distal portion. Epibranchial 3 with proximal portion curved and a dorsally curved posterior uncinat process, proximate to its distal end. Epibranchial 4 broad with anterior and posterior crests giving a rectangular aspect. Upper tooth plate supporting a patch of 30–32 conic teeth, increasing in size posteriorly, arranged in two irregular rows.

Supraorbital sensory canal continuous with three pores, lacking a medial commissure at level of epiphyseal bar (Fig. 5). Sensory pore s1 located medially adjacent to anterior nostril. Sensory pore s3 medial to posterior nostril, at level of its posterior margin. Sensory pore s6 paired, medial and posterior to eye. Pores s6 closer to mid-sagittal plane than to eye and slightly asymmetrical in anteroposterior position, being one pore slightly in advance to its counterpart. Infraorbital sensory canal interrupted in two sections; anterior section with sensory pores i1 and i3 and posterior section with sensory pores i10 and i11. Sensory pore i1 laterally adjacent to anterior nostril and i3 lateral to anterior region of posterior nostril. Sensory pore i10 posterolaterally adjacent to eye and i11 posterior and horizontally aligned to eye. Terminal sensory pore of preopercular canal anterodorsal to opercular patch of odontodes. Sensory pore of pterotic branch just dorsal to opercular patch of odontodes and concealed by dorsal margin of opercular fold. Lateral line canal short with two pores above pectoral-fin base. Sensory pore ll1 ventral to main lateral line canal and ll2 terminus of main lateral line canal, extending up to posterior end of pectoral-fin base.

Precaudal free vertebrae 5–6 and caudal vertebrae 30–31, totaling 37 vertebrae. First 10–11 vertebrae bearing ribs. First hemal spine on vertebra 13–14. Skin of body with minute papillae, visible only under stereomicroscope. Anus at vertical through base of second branched dorsal-fin ray. Anus and urogenital papilla closer to anal-fin origin than to pelvic-fin base.

Pectoral fin with i,7 rays. First ray longest, projected beyond margin of fin as a moderately long filament (filamentous portion *ca.* 1/3 of respective fin ray length). Posterior margin of pectoral fin rounded. Pectoral complex radial cartilaginous (Fig. 6). Scapulocoracoid with long anterior slender process ending in pointed tip.

Pelvic fin with i,4 rays and relatively long lateral splint with relatively long anterior portion, forming obtuse angle with posterior portion aligned to anteroposterior axis. First and second branched rays longest. Inner margins of pelvic-fin bases close to each other (internal distance *ca.* 30% of fin base). Posterior margin of fin rounded, reaching anus. Basypterygium with two long anterior processes approximately of same length (left basypterygium of one *cs* paratype, 50.9 mm SL, with a broad base short anterior process, adjacent to pelvic symphysis). Short distally rounded posterior process at posteromedial corner of basypterygium.

Dorsal fin with three procurrent rays and ii,7 principal rays. Distal margin straight to slightly convex. First branched ray longest. Origin of fin at vertical through last third of pelvic fin. Supporting elements of dorsal fin represented by eight basal radials and six distal radials. Distal radials associated with second to penultimate basal radials. First pterygiophore inserted posterior to neural spine of vertebrae 18–20. Last pterygiophore inserted anterior to neural spine of vertebrae 22–23.

Anal fin with three procurrent rays and ii,5 principal rays. Base of anal fin shorter than dorsal-fin base. Distal margin of fin almost straight. First branched ray longest. Origin of fin through vertical between base of third and fourth branched dorsal-fin rays. Fin rays supported by six basal radials and four distal radials. Distal radials associated with second to penultimate basal radials. First pterygiophore inserted posterior to hemal spine of vertebrae 22–23. Last pterygiophore inserted anterior to hemal spine of vertebra 25.

Caudal fin emarginate with i, 5+6, i principal rays. Outermost branched rays of dorsal and ventral lobes distinctly longest. Dorsal procurrent rays 14, inserted posterior to neural spine of vertebra 31. Ventral procurrent

rays 11, inserted posterior to hemal spine of vertebra 32. Caudal skeleton with three plates; ventral plate represented by parhypural fused to hypurals 1 and 2, middle plate by hypural 3, and dorsal plate by fused hypurals 4 and 5. Hypurapophysis type C (Lundberg & Baskin, 1969). Epural absent. Neural spine of compound caudal vertebra complete and relatively short (*ca.* 1/3 of length of preceding neural spine).

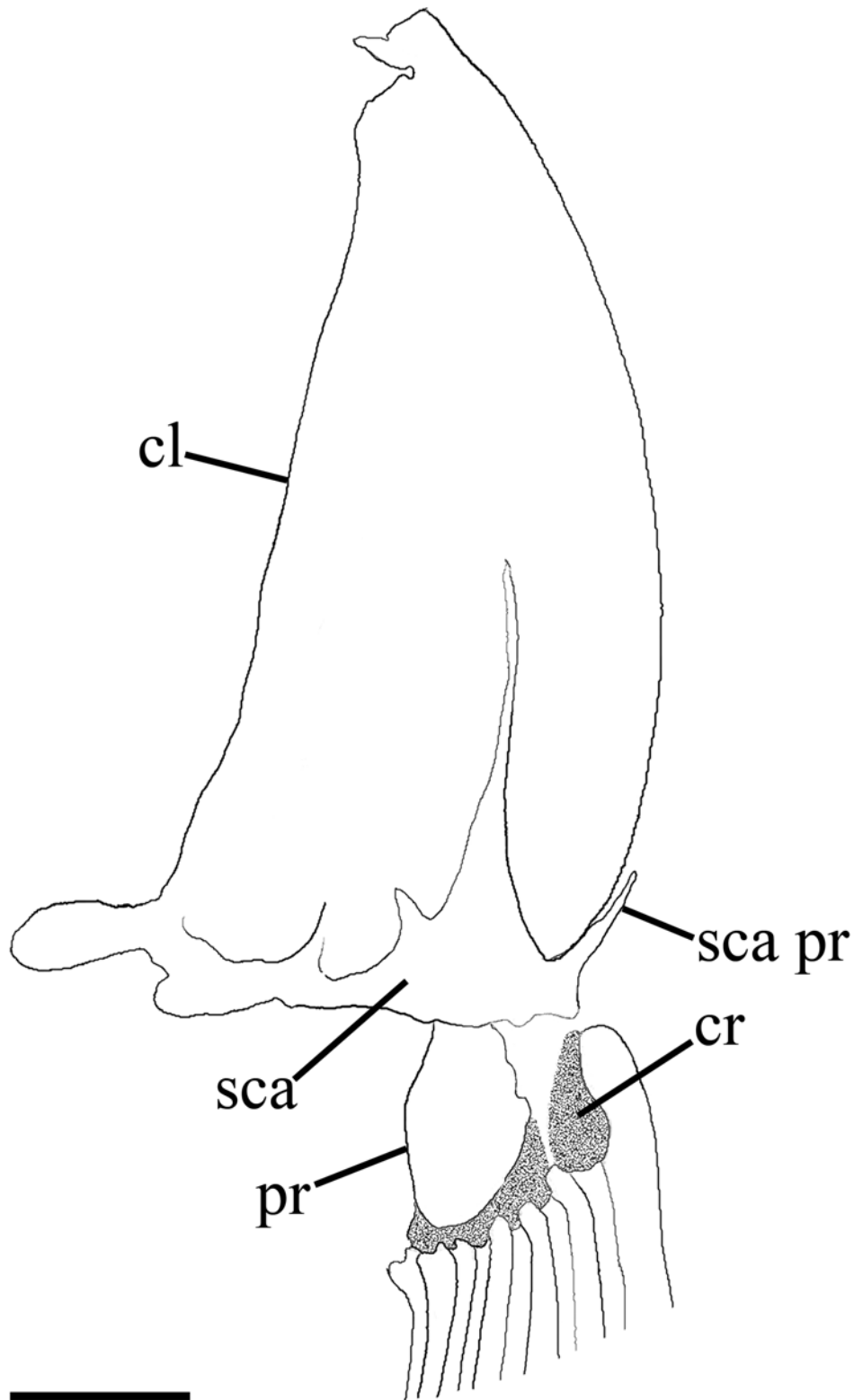


FIGURE 6. Ventral view of left pectoral girdle and fin of *Trichomycterus tetuanensis*, paratype, CZUT-IC 904, 50.9 mm SL. Abbreviations: cl, cleithrum; cr, complex radial; pr, pectoral radial; sca, scapulocoracoid; sca pr, scapulocoracoid process (scale bar = 1 mm).

Coloration in ethanol. Ground color of dorsum of head and body and sides of body light brown, ventral surface of head and belly lighter. Dark diffuse dots irregularly scattered on dorsum, dorsolateral region of trunk anterior to pelvic fin insertion, and entire flank including caudal peduncle, just posterior to pelvic fins. Faint dark band along midline from behind opercle to base of caudal fin, continuous posteriorly with darkly pigmented middle caudal-fin rays. Nasal barbel and upper surface of maxillary barbel darkly pigmented. Dorsal surface of head except cheek region darker than ventral surface. Cheek and dorsolateral surface of head, immediately posterior to eye and anterior to opercular patch, lighter than remainder of dorsal surface of head. Opercular and interopercular patches dark with dense blotches of chromatophores. Dorsal surface of pectoral and pelvic-fin rays with chromatophores aligned along their margins. Dorsal, anal, and caudal-fin rays with chromatophores delineating margins of rays. Interradial membranes of fins light brown and translucent, except basal portion of caudal fin with chromatophores densely clustered.

Coloration in life. Ground color greenish yellow with light purple iridescence along flanks (Fig. 3). Dense layer of darker dots uniformly scattered on dorsum and sides of head and body, only cheek region free of dots.

Etymology. The specific epithet “*tetuanensis*” refers to the río Tetuán, type locality of the species.

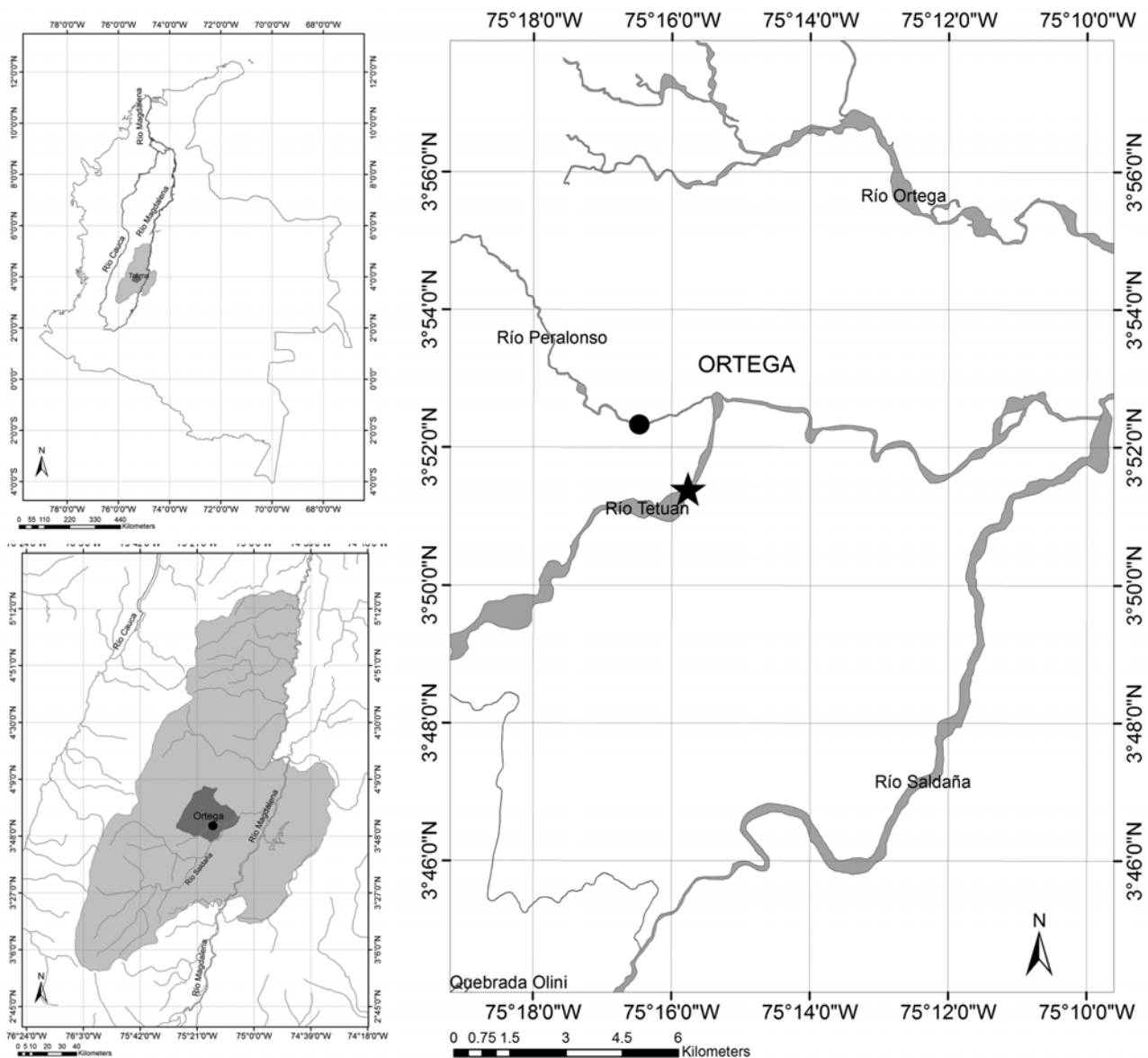


FIGURE 7. Maps of Departamento del Tolima and Municipio Ortega, showing collecting localities of *Trichomycterus tetuanensis* (type locality star).



FIGURE 8. Type locality of *Trichomycterus tetuanensis*, río Tetuán (03°51'23.866"N 75°16'47.508"W), Ortega, Tolima, Colombia, 6 June 2003. Photograph by Jorge E. García-Melo.

Distribution. *Trichomycterus tetuanensis* is only known from the río Tetuán and its main tributary río Peralonso (Fig. 7). The río Tetuán is a lowland river (Fig. 8) that empties into the río Saldaña of the upper basin of the río Magdalena, on the east versant of the Cordillera Central of Colombia. The new species is sympatrically found with *T. banneau*, which is widely distributed in the upper basin of the río Magdalena (García-Melo, 2009).

Discussion

Maldonado-Ocampo *et al.* (2005) provided an account of *Trichomycterus striatus*, with a brief description and a list of recorded lots in Colombian collections. This list includes all CZUT-IC paratype lots of *T. tetuanensis*, from which the holotype and the IAVH-P paratype lot also originate. The above mentioned description explicitly establishes that *T. striatus* has a round caudal fin (agreeing with the original description), but is clearly contrary to what is found in specimens of *T. tetuanensis* (i.e. caudal-fin shape characteristically emarginate). Aside from this quite obvious difference, both species show a similar overall appearance that might explain the misidentification of *T. tetuanensis* by these authors. However, *T. tetuanensis* further differs from *T. striatus* by its larger opercular patch of odontodes, with 6-8 dorsoventral transverse rows of odontodes, giving an almost circular appearance to the external patch, in contrast to the elliptical patch of odontodes of *T. striatus*, with 4 or less dorsoventral transverse rows of odontodes.

Trichomycterus tetuanensis displays a character combination that only fits with the general and vague definition of *Trichomycterus*. The new species has all synapomorphies proposed by de Pinna (1998) for the trichomycterid clade excluding the basal copionodontines and trichogenines, while lacking those derived features supporting the distal clade composed of tridentines, stegophilines, vandelliines, sarcoglanidines, and glanapterygines, the so-called TSVSG clade (Costa & Bockmann, 1993). This places *T. tetuanensis* in the unresolved section of the trichomycterid phylogeny that corresponds to trichomycterine genera. Within

trichomycterines (as defined by Datovo & Bockmann, 2010), the new species lacks the diagnostic characters proposed for *Bullockia*, *Hatcheria*, and *Scleronema* (Arratia, 1990), *Eremophilus* (Arratia, 1990, DoNascimento *et al.* 2014a), *Ituglanis* (Costa & Bockmann, 1993), *Rhizosomichthys* (Schaefer & Fernández, 2009), and *Silvinichthys* (Arratia, 1998; Fernández & de Pinna, 2005), leaving as the only available option its assignment to the non-monophyletic genus *Trichomycterus*.

Recent efforts have been conducted to identify and diagnose smaller putative monophyletic subunits within *Trichomycterus* (e.g. Wosiacki & de Pinna, 2008a, b; Barbosa & Costa, 2010; Fernández & Vari, 2012). One of these subunits includes the type species of the genus (*T. nigricans*), along with *T. caipora*, *T. giganteus*, and *T. immaculatus* (Eigenmann & Eigenmann), all restricted to southeastern Brazil (Lima *et al.*, 2008). This group of species (here named the *Trichomycterus stricto sensu* clade) was diagnosed by having a high number of branched pectoral-fin rays (8), and high numbers of interopercular and opercular odontodes (59–70 and 23–30, respectively). *Trichomycterus tetuanensis* shares with these species an elevated number of opercular odontodes (21–39) that even exceeds the range provided by Lima *et al.* (2008). Most trichomycterids have less than 23 opercular odontodes, including the basal copionodontines (*Glaphyropoma spinosum* Bichuette, de Pinna & Trajano is the only copionodontine with opercular odontodes, having 5–6) and trichogenines (2–13). Most *Trichomycterus* species have less than 21 odontodes (Lima *et al.*, 2008), except *T. boylei* (10–31), *T. brunoi* (14–23), *T. mimosensis* (15–21), *T. argos* (20–22), *T. jacupiranga* (20–23), *T. ruitoquensis* Ardila Rodríguez (20–25), *T. maracaya* (20–26), *T. giganteus* (23–24), *T. tupinamba* (23–26), *T. nigricans* (23–27), *T. papilliferus* (23–28), *T. iheringi* (Eigenmann) (25–27), and *T. caipora* (26–28). *Trichomycterus tetuanensis* is distinguished from these species with numerous opercular odontodes by having an even higher number of opercular odontodes and by its different pigmentation pattern (dark brownish or pale orange-brownish, lacking spots and dots in *T. boylei*; light brown with dark brown spots coalesced forming a vermiculate or reticulate pattern in *T. brunoi*; transverse dark bars on dorsum in *T. mimosensis*; cream or dark brown with spots smaller than eye, more densely grouped dorsally in *T. argos*; uniformly gray with poorly defined mid-lateral stripe in *T. jacupiranga*; light brown with three horizontal rows of spots in *T. ruitoquensis*; four longitudinal rows of well-defined blotches in *T. maracaya*; homogeneous color pattern in *T. nigricans*; broad dark stripe along lateral midline of body, overlapped by superficial dark brown spots in *T. giganteus*; gray, lacking spots or dots in *T. papilliferus*; longitudinal row of dark spots along midline of flank in *T. tupinamba*; uniform light tan with numerous, poorly defined small spots over the dorsal and lateral portions of the head, trunk and caudal peduncle, with spots larger at dorsal trunk and caudal peduncle, and gradually less numerous and smaller ventrally in *T. iheringi*; four irregular longitudinal rows of rounded blotches on trunk in *T. caipora*).

Trichomycterus tetuanensis also has a high number of interopercular odontodes (42–52), although Lima *et al.* (2008) contrasted a very wide range of 19–52 odontodes with 59–70 odontodes diagnostic for the *Trichomycterus stricto sensu* clade. However, the range of *T. tetuanensis* is closer to the latter than the ranges verified in most of the recently described species of the genus, indicating that this character should be reevaluated in more precise terms.

The number of pectoral-fin rays has been considered conservative within Trichomycterinae (Bockmann & Sazima, 2004). However some intraspecific variation is verified at least in *T. boylei*, *T. plumbeus*, *T. yuska*, and *T. zonatus* (Eigenmann) (6–7 branched rays), *T. areolatus* Valenciennes, *T. barbouri* (Eigenmann), *T. duellmani*, *T. lewi* Lasso & Provenzano, *T. megantoni*, *T. rivulatus* Valenciennes, and *T. steindachneri* DoNascimento, Prada-Pedrerros & Guerrero-Kommritz (7–8 branched rays), *T. hualco*, and *T. laucaensis* Arratia (7–9 branched rays), and *T. emanueli* (Schultz), *T. minus*, *T. oroyae* (Eigenmann & Eigenmann), *T. rubbioli*, *T. sandovali*, *T. sketi* Castellanos-Morales and *T. taeniops* Fowler (8–9 branched rays). Also a limited variation was verified in some syntypes of *T. immaculatus*, where the smaller specimen (49.6 mm SL) of the lot MCZ 8307 has seven branched rays and the larger specimen (123.7 mm SL) of the same lot has asymmetrically eight and seven branched rays. *Trichomycterus tetuanensis* has a constant number of seven branched pectoral-fin rays, which overlaps with the minimum count found in *T. immaculatus*. On the other hand, several species other than those of the *Trichomycterus stricto sensu* clade also have either a fixed number of eight branched pectoral-fin rays or counts that encompass this value: *T. areolatus*, *T. barbouri*, *T. cachiraensis* Ardila Rodríguez, *T. dorsostriatum* (Eigenmann), *T. duellmani*, *T. emanueli*, *T. hualco*, *T. latistriatus* (Eigenmann), *T. laucaensis*, *T. lewi*, *T. megantoni*, *T. meridae* Regan, *T. minus*, *T. motatanensis* (Schultz), *T. nietoi* Ardila Rodríguez, *T. oroyae*, *T. piurae* (Eigenmann), *T. pradensis* Sarmento-Soares, Martins-Pinheiro, Aranda & Chamon, *T. sketi*, *T. rivulatus*, *T. roigi* Arratia & Menu-Marque, *T. rubbioli*, *T. sandovali*, *T. santanderensis*, *T. spelaeus* DoNascimento, Villarreal & Provenzano, *T. steindachneri*, *T. taeniops*, *T.*

therma, *T. uisae* Castellanos-Morales, and *T. weyrauchi* (Fowler). Some of these species have been proposed to belong to different monophyletic groups not related to the species of the *Trichomycterus stricto sensu* clade (e.g. *T. minus*, Fernández & Vari, 2012; *T. duellmani* and *T. therma*, Fernández & Miranda, 2007; *T. cachiraensis* and *T. steindachneri*, DoNascimento *et al.*, 2014b). Additionally, *Bullockia* and *Hatcheria* have eight branched pectoral-fin rays, demonstrating that this pectoral-fin ray count is homoplastically distributed in trichomycterines. However, we do not discard the potential of this character as informative for several subgroups of Trichomycteridae, including the *Trichomycterus stricto sensu* clade.

Wosiacki (2005) also offered character evidence to diagnose a more inclusive group that includes *T. nigricans*, *T. giganteus* (member of the *Trichomycterus stricto sensu* clade), *T. alternatus* (Eigenmann), *T. brasiliensis* Lütken, *T. mirissumba* Costa, *T. mimonha* Costa, and *T. paquequerense* (Miranda Ribeiro). This group shares the presence of a variably long branch of the laterosensory system that emerges medially from the supraorbital canal at the level of the epiphyseal bar, and communicates with sensory pore s6. This branch can be fused to its counterpart giving origin to a single median pore s6 as in *T. alternatus*, *T. caipora*, *T. giganteus*, *T. jacupiranga*, *T. nigricans*, and *T. paquequerense*, or, when separated, the paired pores s6 are very close to each other. This last condition is verified in *T. tetuanensis* (Fig. 5). The complete fusion of the medial membranous branches, externally verified as the presence of a single medial pore, was interpreted as a more derived condition by Wosiacki (2005), an interpretation with which we concur.

Another derived character supporting a larger putative clade of species from south and southeastern Brazil [*Trichomycterus castroi* de Pinna, *T. davisii* (Haseman), *T. guaraquessaba* Wosiacki, *T. iheringi*, *T. immaculatus*, *T. itatiayae* Miranda Ribeiro, *T. mirissumba*, *T. mboyacy* Wosiacki & Garavello, *T. naipi* Wosiacki & Garavello, *T. nigricans*, *T. papilliferus*, *T. plumbeus*, *T. stawiarski* (Miranda Ribeiro), *T. taroba* Wosiacki & Garavello, *T. triguttatus* (Eigenmann), and *T. zonatus*] is a window at least half of the diameter of the optic foramen in the orbitosphenoid (Wosiacki, 2005). This window actually corresponds to the optic foramen, given the optic nerve leaves the neurocranium through this opening in the orbitosphenoid in the majority of trichomycterids (DoNascimento, 2013), while the optic foramen of Wosiacki (2005) corresponds to the trigeminofacial foramen, anteriorly framed by the orbitosphenoid and posteriorly delimited by the compound pterosphenoïd+sphenotic+prootic bone. Wosiacki (2005) correctly interpreted the enlarged condition of his orbitosphenoid window (optic foramen) as apomorphic, and pointed out that it is lacking in the Andean and trans-Andean species of *Trichomycterus*, which we confirm for *T. tetuanensis*.

Datovo & Bockmann (2010) recently challenged the traditional view of Trichomycterinae as a non-monophyletic group within the family (Baskin, 1973; de Pinna, 1989), by providing evidence of a putative homoplasy-free synapomorphy (posterior portion of *levator internus 4* originating from the dorsal surface of the posttemporo-supracleithrum). This single synapomorphy was found to be shared by 16 species examined by the authors, representing four of the six genera of Trichomycterinae (as defined by Arratia, 1990), including *Ituglanis*. In the case of *T. tetuanensis*, we found that the origin of the posterior portion of the *levator internus 4* corresponds to the plesiomorphic character state (i.e. restricted to the neurocranial floor), indicating that the homoplasy free nature attributed to this character does not hold for the whole Trichomycterinae or for *Trichomycterus*. Datovo & Bockmann (2010) already commented on this possibility, taking into account their limited taxonomic sample of trichomycterines and their results on the high degree of inter and intraspecific variation of various morphological traits in Trichomycteridae (especially those characters proposed as synapomorphies of Trichomycterinae by Arratia, 1990). Additionally we checked the condition of two other myological characters proposed by Datovo & Bockmann (2010) that are apparently informative for the internal relationships of Trichomycterinae: *extensor tentaculi* originating from neurocranium and suspensorium, and secondary-ventral section of the *dilatator operculi* expanded anteriorly to reach articular region of opercle with hyomandibula (their characters 12 and 33, respectively). The first character is shared by *Trichomycterus davisii* and *T. stawiarski*, two species distributed in the rio Iguaçú drainage in southern Brazil. The second character has a wider taxonomic distribution, encompassing a series of Austral Andean species (*Bullockia maldonadoi*, *Hatcheria macraei*, *Trichomycterus areolatus*, and *T. chiltoni*) and two southern Brazilian species (*Trichomycterus immaculatus* and *T. zonatus*). These two characters were verified to show the plesiomorphic condition in *T. tetuanensis*.

Under the above scenario of conflicting taxonomic distribution of various phylogenetically informative characters for the Trichomycterinae and its internal relationships, a straightforward interpretation of the common shared presence of a high number of opercular odontodes and paired s6 pores closer to the sagittal plane in *T.*

tetuanensis and some Brazilian species (especially those pertaining to the *Trichomycterus stricto sensu* clade) is not possible. This hypothesis would require invoking the reversal of a greater number of characters in *T. tetuanensis* (dorsal insertion of *levator internus 4*, large optic foramen, and secondary-ventral section of the *dilatator operculi* expanded anteriorly). Consequently, the more parsimonious interpretation is to suppose the homoplastic occurrence of the two shared apomorphic conditions of *T. tetuanensis*, which leaves the systematic placement of this species within *Trichomycterus* unresolved. Hence the necessity of reevaluating all these characters in the context of a comprehensive phylogenetic analysis of Trichomycterinae is undeniable in order to properly assess the phylogenetic affinities of this species.

References

- Arratia, G. (1990) The South American Trichomycterinae (Teleostei: Siluriformes), a problematic group. *In*: Peters, G. & Hutterer, R. (Eds.), *Vertebrates in the Tropics*. Museum Alexander Koenig, Bonn, pp. 395–403.
- Arratia, G. (1998) *Silvinichthys*, a new genus of trichomycterid catfishes from the Argentinian Andes, with redescription of *Trichomycterus nigricans*. *Ichthyological Exploration of Freshwaters*, 9, 347–370.
- Arratia, G. & Huaquin, L. (1995) Morphology of the lateral line system and of the skin of diplomystid and certain primitive loricarioid catfishes and systematic and ecological considerations. *Bonner Zoologische Monographien*, 36, 1–110.
- Arratia, G. & Menu-Marque, S. (1984) New catfishes of the genus *Trichomycterus* from the high Andes of South America (Pisces, Siluriformes) with remarks on distribution and ecology. *Zoologische Jahrbücher. Abteilung für Systematik, Ökologie und Geographie der Tiere*, 111, 493–520.
- Barbosa, M.A. & Costa, W.J.E.M. (2010) Seven new species of catfish genus *Trichomycterus* (Teleostei: Siluriformes: Trichomycteridae): from southeastern Brazil and re-description of *T. brasiliensis*. *Ichthyological Exploration of Freshwaters*, 21, 97–122.
- Baskin, J.N. (1973) *Structure and relationship of the Trichomycteridae*. Unpublished Ph.D. Dissertation, City University of New York, New York, 389 pp.
- Bockmann, F.A. & Sazima, I. (2004) *Trichomycterus maracaya*, a new catfish from the upper rio Paraná, southeastern Brazil (Siluriformes: Trichomycteridae), with notes on the *T. brasiliensis* species-complex, *Neotropical Ichthyology*, 2, 61–74. <http://dx.doi.org/10.1590/S1679-62252004000200003>
- Costa, W.J.E.M. & Bockmann, F.A. (1993) Un nouveau genre néotropical de la famille des Trichomycteridae (Siluriformes: Loricarioidei). *Revue Française d'Aquariologie et Herpétologie*, 20, 43–46.
- Datovo, A. & Bockmann, F.A. (2010) Dorsolateral head muscles of the catfish families Nematogenyidae and Trichomycteridae (Siluriformes: Loricarioidei): comparative anatomy and phylogenetic analysis. *Neotropical Ichthyology*, 8, 193–246. <http://dx.doi.org/10.1590/S1679-62252010000200001>
- DoNascimento, C. (2013) *Sistemática y relaciones filogenéticas de la subfamilia de bagres parásitos Stegophilinae (Siluriformes, Trichomycteridae)*. Unpublished Doctoral thesis, Universidad Central de Venezuela, Caracas, 343 pp.
- DoNascimento, C. (2015) Morphological evidence for the monophyly of the subfamily of parasitic catfishes Stegophilinae (Siluriformes, Trichomycteridae) and phylogenetic diagnoses of its genera. *Copeia*, 103, 933–960. <http://dx.doi.org/10.1643/CI-14-132>
- DoNascimento, C., Prada-Pedrerros, S. & Guerrero-Kommritz, J. (2014a) *Trichomycterus venulosus* (Steindachner, 1915), a junior synonym of *Eremophilus mutisii* Humboldt, 1805 (Siluriformes: Trichomycteridae) and not an extinct species. *Neotropical Ichthyology*, 12, 707–715. <http://dx.doi.org/10.1590/1982-0224-20130236>
- DoNascimento, C., Prada-Pedrerros, S. & Guerrero-Kommritz, J. (2014b) A new catfish species of the genus *Trichomycterus* (Siluriformes: Trichomycteridae) from the río Orinoco versant of Páramo de Cruz Verde, Eastern Cordillera of Colombia. *Neotropical Ichthyology*, 12, 717–728. <http://dx.doi.org/10.1590/1982-0224-20140005>
- Dutra, G.M., Wosiacki, W.B. & de Pinna, M.C.C. (2012) *Trichomycterus anhangá*, a new species of miniature catfish related to *T. hasemani* and *T. johnsoni* (Siluriformes: Trichomycteridae) from the Amazon basin, Brazil. *Neotropical Ichthyology*, 10, 225–231. <http://dx.doi.org/10.1590/S1679-62252012000200001>
- Eigenmann, C.H. (1918) The Pygidiidae, a family of South American catfishes. *Memoirs of the Carnegie Museum*, 7, 259–398.
- Eschmeyer, W.N. & Fong, J.D. (2016) *Species by family/subfamily*. Electronic version. Available from: <http://research.calacademy.org/research/ichthyology/catalog/SpeciesByFamily.asp>. (accessed 21 April 2016)
- Fernández, L. & Miranda, G. (2007) A catfish of the genus *Trichomycterus* from a thermal stream in southern South America (Teleostei, Siluriformes, Trichomycteridae), with comments on relationships within the genus. *Journal of Fish Biology*, 71, 1303–1316. <http://dx.doi.org/10.1111/j.1095-8649.2007.01589.x>
- Fernández, L. & de Pinna, M.C.C. (2005) Phreatic catfish of the genus *Silvinichthys* from southern South America (Teleostei,

- Siluriformes, Trichomycteridae). *Copeia*, 2005, 100–108.
<http://dx.doi.org/10.1643/CI-03-158R2>
- Fernández, L. & Vari, R.P. (2009) New species of *Trichomycterus* from the Andean Cordillera of Argentina (Siluriformes: Trichomycteridae). *Copeia*, 2009, 195–202.
<http://dx.doi.org/10.1643/CI-08-083>
- Fernández, L. & Vari, R.P. (2012) New species of *Trichomycterus* (Teleostei: Siluriformes) from the Andean Cordillera of Argentina and the second record of the genus in thermal waters. *Copeia*, 2012, 631–636.
<http://dx.doi.org/10.1643/CI-12-035>
- Ferrer, J. & Malabarba, L.R. (2013) Taxonomic review of the genus *Trichomycterus* Valenciennes (Siluriformes: Trichomycteridae) from the laguna dos Patos system, Southern Brazil. *Neotropical Ichthyology*, 11, 217–246.
<http://dx.doi.org/10.1590/S1679-62252013000200001>
- García-Melo, L.J. (2009) *Relaciones filogenéticas de Trichomycterus (Siluriformes: Trichomycteridae) en el alto Magdalena*. M.Sc. dissertation, Universidad del Tolima, Ibagué, Colombia, 171 pp.
- Lima, S.M.Q., Lazzarotto, H. & Costa, W.J.E.M. (2008) A new species of *Trichomycterus* (Siluriformes: Trichomycteridae) from lagoa Feia drainage, southeastern Brazil. *Neotropical Ichthyology*, 6, 315–322.
<http://dx.doi.org/10.1590/S1679-62252008000300004>
- Lundberg, J.G. & Baskin, J.N. (1969) The caudal skeleton of the catfishes, Order Siluriformes. *American Museum Novitates*, 2398, 1–49.
- Maldonado-Ocampo, J., Ortega-Lara, A., Oviedo, J.S.U., Vergara, G.G., Villa-Navarro, F.A., Gamboa, L.V., Prada-Pedrosos, S. & Rodríguez, C.A., (2005) *Peces de los Andes de Colombia*. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt. Impreso en Bogotá, D.C., Colombia, 346 pp.
- Myers, G.S. (1944) Two extraordinary new blind nematognath fishes from the Rio Negro, representing a new subfamily of Pygidiidae, with a rearrangement of the genera of the family and illustrations of some previously described genera and species from Venezuela and Brazil. *Proceedings of the California Academy of Sciences*, Series 4, 23, 591–602.
- de Pinna, M.C.C. (1989) A new sarcoglanidine catfish, phylogeny of its subfamily, and an appraisal of the phyletic status of the Trichomycterinae (Teleostei, Trichomycteridae). *American Museum Novitates*, 2950, 1–25.
- de Pinna, M.C.C. (1992) *Trichomycterus castroi*, a new species of trichomycterid catfish from the Rio Iguazu of Southeastern Brazil (Teleostei: Siluriformes). *Ichthyological Exploration of Freshwaters*, 3, 89–95.
- de Pinna, M.C.C. (1998) Phylogenetic relationships of Neotropical Siluriformes (Teleostei: Ostariophysi): historical overview and synthesis of hypotheses. In: Malabarba, L.R., Reis, R.E., Vari, R.P., Lucena, Z.M.S. & Lucena, C.A.S. (Eds.), *Phylogeny and Classification of Neotropical Fishes*. EDIPUCRS, Porto Alegre, pp. 279–330.
- de Pinna, M.C.C. & Wosiacki, W. (2003) Trichomycteridae. In: Reis, R.E., Kullander, S.O. & Ferraris, C.J. Jr. (Eds.), *Check list of the Freshwater Fishes of South and Central America*. EDIPUCRS, Porto Alegre, pp. 270–290.
- Sabaj Pérez, M.H. (Ed.) (2014) *Standard symbolic codes for institutional resource collections in herpetology and ichthyology: an online reference*. Version 5.0. Available from: <http://www.asih.org/> (accessed 4 May 2016)
- Schaefer, S.A. & Aquino, A.E. (2000) Postotic laterosensory canal and pterotic branch homology in catfishes. *Journal of Morphology*, 246, 212–227.
[http://dx.doi.org/10.1002/1097-4687\(200012\)246:3%3C212::AID-JMOR5%3E3.0.CO;2-S](http://dx.doi.org/10.1002/1097-4687(200012)246:3%3C212::AID-JMOR5%3E3.0.CO;2-S)
- Schaefer, S.A. & Fernández, L. (2009) Redescription of the pez graso, *Rhizosomichthys totae* (Trichomycteridae), of Lago de Tota, Colombia, and aspects of cranial osteology revealed by microtomography. *Copeia*, 2009, 510–522.
<http://dx.doi.org/10.1643/CI-08-186>
- Taylor, W.R. & Van Dyke, G. (1985) Revised procedures for staining and clearing small fishes and other vertebrates for small bone and cartilage study. *Cybium*, 9, 107–119.
- Tchernavin, V.V. (1944) A revision of some Trichomycterinae based on material preserved in the British Museum (Natural History). *Proceedings of the Zoological Society of London*, 114, 234–275.
<http://dx.doi.org/10.1111/j.1096-3642.1944.tb00219.x>
- Wosiacki, W.B. (2005) A new species of *Trichomycterus* (Siluriformes: Trichomycteridae) from south Brazil and redescription of *T. iheringi* (Eigenmann). *Zootaxa*, 1040, 49–64.
- Wosiacki, W.B. & de Pinna, M.C.C. (2008a) *Trichomycterus igobi*, a new catfish species from the rio Iguazu drainage: the largest head in Trichomycteridae (Siluriformes: Trichomycteridae). *Neotropical Ichthyology*, 6, 17–23.
<http://dx.doi.org/10.1590/S1679-62252008000100003>
- Wosiacki, W.B. & de Pinna, M.C.C. (2008b) A new species of the Neotropical catfish genus *Trichomycterus* (Siluriformes: Trichomycteridae) representing a new body shape for the family. *Copeia*, 2008, 273–278.
<http://dx.doi.org/10.1643/CI-06-237>