A new species of cave catfish, genus *Trichomycterus* (Siluriformes: Trichomycteridae), from the Magdalena River system, Cordillera Oriental, Colombia

Una nueva especie de bagre de caverna, género *Trichomycterus* (Siluriformes: Trichomycteridae), del sistema río Magdalena, cordillera Oriental, Colombia

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Abstract

A new species of troglomorphic catfish is described from de Gedania Cave, located in the middle Suárez River drainage, Magdalena River system, Colombia. The new species can be distinguished from its congeners by the combination of the following characters: reduction or loss of the cornea, reduction of eyes and skin pigmentation, very long nasal and maxillary barbels (maximum of 160% and 135% of HL, respectively), nine branched pectoral-fin rays, first unbranched ray of the pectoral fin prolonged as a long filament, reaching 80% of pectoral-fin length, anterior cranial fontanel connected with the posterior fontanel through an opening of variable length and width, first dorsal-fin pterygiophore inserted between neural spines of free vertebra 13-14 and free vertebrae 33-34. The presence of troglomorphisms such as regression of the eyes, reduction of skin pigmentation and long barbels suggest the troglobitic status of this species. A comparative analysis with other species of *Trichomycterus* from epigean and hypogean environments is presented.

Keywords. Andean region. Subterranean habitat. Systematics. Taxonomy. Troglobite.

Resumen

Una nueva especies de bagre troglomorfo es descrito de la cueva de Gedania, cuenca media del río Suárez, sistema río Magdalena, Colombia. La nueva especie puede distinguirse de sus congéneres por la combinación de los caracteres de reducción o pérdida de la córnea, reducción de ojos y pigmentación de la piel, barbillas nasales y maxilares muy largas (máximo 160 % y 135 % de LC respectivamente), nueve radios ramificados de la aleta pectoral, primer radio simple de la aleta pectoral prolongado como un filamento largo, alcanzando 80 % de la longitud de la aleta pectoral, fontanela craneal anterior conectada con la fontanela posterior por una apertura de amplitud y longitud variable, primer pterigioforo de la aleta dorsal insertado entre la espina neural de la vértebra libre 13-14 y 33-34 vertebras libres. La presencia de características troglomorficas como la regresión de ojos y reducción de la pigmentación, así como barbillas largas sugieren el estatus troglobítico de la especie. Se presenta un análisis comparativo con otras especies de *Trichomycterus* de ambientes epigeos e hipogeos.

Palabras clave. Hábitat subterráneo. Región andina. Sistemática. Taxonomía. Troglobio.

Introduction

Trichomycteridae is a family of Neotropical freshwater catfishes widely distributed in Central and South America, on both sides of the Andes mountain range from sea level to 4500 m a.s.l (de Pinna & Wosiacki, 2003). Currently, the family represents one of the most species-rich groups of Siluriformes with at least 300 valid species and 41 valid genera (Eschmeyer *et al*., 2017). Its monophyly is well corroborated and its most conspicuous synapomorphies are based on its highly specialized opercular-interopercular apparatus (de Pinna, 1998; Datovo & Bockmann, 2010). The genus *Trichomycterus* is the most diverse within the Trichomycteridae, containing over 170 valid species (Eschmeyer *et al*., 2017). In Colombia, the genus is represented by 41 species, of which eight have been recently described: *Trichomycterus steindachneri* (DoNascimiento *et al*., 2014), *T. nietoi* (Ardila-Rodríguez, 2014), *T. tetuanensis* (García-Melo *et al*., 2016) and *T. arhuaco*, *T. garciamarquezi*, *T. kankuamo*, *T. manaurensis*, *T. montesi* (Ardila-Rodríguez, 2016). Trans-Andean drainages (Magdalena, Cauca, San Juan, and Sinú basins) have the largest number of species (Castellanos-Morales & Galvis, 2012).

Trichomycterid catfishes are among the most successful colonizers of subterranean habitats (Castellanos-Morales, 2008), with troglobitic and troglophilic populations (Mattox *et al*., 2008), including several troglobitic species in 4 genera, *Silvinichthys* (Argentina), *Glaphyropoma* (Brazil), *Ituglanis* (Brazil), and *Trichomycterus* (Bolivia, Brazil, Colombia and Venezuela) (Proudlove, 2010). Currently 14 hypogean species of *Trichomycterus* have been reported in South America; Colombia has the largest number with 6 species: *T. sandovali* Ardila-Rodríguez, 2006 (Don Juan cave), *T. santanderensis* Castellanos-Morales, 2007 (El Puente Cave), *T. sketi* Castellanos-Morales, 2010 (Del Indio Cave), and *T. uisae* Castellanos-Morales, 2008 (El Misterio Cave), and at least 2 additional undescribed species (Castellanos-Morales *et al*., 2011, Castellanos-Morales & Galvis, 2012); Brazil has 3 species: *T. itacarambiensis* Trajano and de Pinna, 1996 (Olhos d'Água Cave), *T. dali* Rizzato, Costa-Jr, Trajano and Bichuette, 2011 (Saracura y Buraco das Abelhas Caves), and *T. rubbioli* Bichuette y Rrizzato, 2012 (Lapa dos Peixes Cave), and 2 undescribed forms (Bichuette & Rizzato, 2012); 2 species are known from Venezuela: *T. spelaeus* DoNascimiento, Villarreal & Provenzano, 2001 (Punto Fijo Cave) and 1 undescribed species from El Guácharo Cave, a species previously considered to be a hypogean population of *T. conradi* (DoNascimiento, 2005); finally 1 species is found in Bolivia: *Trichomycterus chaberti* Durand, 1968 (Umayalanta Cave). These species (except *T. sketi*) show troglomorphic characteristics (e.g. reduced eyes or not visible externally and, pigmentation reduction), indicating a troglobitic condition. This paper describes a new subterra-nean, troglomorphic *Trichomycterus* species from the middle Suárez River drainage, Magdalena Basin, La Paz municipality, southwestern Santander Department, in the Andean region of Colombia.

Materials and methods

Measurements were taken point-to-point with dial calipers from the left side of each specimen with the aid of a stereomicroscope. Methodology and terminology for measurements and counts follow de Pinna (1992), with the addition of length of first and second pectoral-fin rays, eye diameter and interopercular patch length. Measurements are presented in percentage of standard length (SL) and head length (HL). Osteological data and number of branchiostegal and procurrent rays, vertebrae, ribs, fin rays, number and position of supporting elements of dorsal and anal fins, and other osteological features were obtained from two paratypes cleared and double-stained (C&S) for bone and cartilage following the method of Taylor & Van Dyke (1985). Osteological nomenclature follows Bockmann *et al*. (2004). Vertebral counts include only the free vertebrae (posterior to the Weberian complex), and the compound caudal centrum (PU1+U1) was counted as one element (Lundberg &

Baskin, 1969). The presence or absence of the cornea was determined by direct observation throughout light stereo microscope. Color was determined according to the Munsell soil color chart (M) (1994). Morphological data for other species are based on personal observations, literature and available images at the Image Base website from the All Catfish Species Inventory (Morris *et al*., 2006) and the Illustrated and online catalog of type specimens from the *Instituto de Investigación de Recursos Biológicos Alexander von Humboldt* (DoNascimiento *et al.*, 2016). Institutional abbreviations follow Sabaj (2016).

Results

Trichomycterus donascimientoi, new species

Figure 1. *Trichomycterus donascimientoi*, CAC-CDMB 224, holotype, 78.0 mm SL, Colombia, Santander department, La Paz municipality, Gedania Cave, Suárez River basin, Magdalena River system. Lateral view of the right side. Scale bar = 1 cm.

Holotype. CAC-CDMB 224, 78.0 mm SL, Colombia, Departamento de Santander, Municipio La Paz, vereda Casas Blancas, cueva de Gedania, 6 km South of town (06°08'07.9" N 73°35'50.4" W, elevation 1871 m), near quebrada La Gran Curí, middle Suárez River drainage, Magdalena River system, César A. Castellanos-M., Fabián Moreno-R & Liliana Toro-M, 15 Dec 2014.

Paratypes. Collected with the holotype. CAC-CDMB 225 (4, 55–76.5 mm SL), CAR 780 (2, 34.2 – 66.5), IAvH-P 16143 (2, 48.8–68.4 mm SL), ICN–

MHN 21744, (2, 46.4–79.9 mm SL), MLS 1578 (1, 66.4 mm SL) UIS-T-2294 (1, 59.1 mm SL).

Diagnosis. *Trichomycterus donascimientoi* is readily distinguished from hypogean congeners by the presence of 33-34 free vertebrae (vs. 35-36 in *T. itacarambiensis, T. sandovali* and *T. santanderensis*; 35 in *T. dali* and *sketi;* 31-32 in *T. rubbioli* and *T. uisae*). *Trichomycterus donascimientoi* can be distinguished from epigean and most hypogean species of the genus by the following combination of characters: reduced skin body pigmentation (except *T. gorgona* and hypogean congeners *T. chaberti, T. itacarambiensis, T. sandovali, T. santanderensis, T. spelaeus* and *T. uisae*); reduced eyes, (vs. eyes well developed in all epigean species, except *T. gorgona,* and the hypogean species, *T. chaberti, T. itacarambiensis*, *T. rubbioli, T. santanderensis, T. sketi* and *T. uisae*) reduction or loss of the cornea (vs. well-developed cornea in all epigean species); long nasal and maxillary barbels (reaching a maximum of 160% and 135% of HL, respectively), except for species with well-developed barbels mostly restricted to subterranean habitats: *T. dali*, *T. rubbioli*, *T. sandovali*, *T. santanderensis*, *T. spelaeus*, *T. sketi* and *T. uisae* and, epigean *T. longibarbatus*. *Trichomycterus donascimientoi* is further distinguished from almost all congeners (except epigean *T. hualco* and *T. roigi* and the cave restricted *T. dali*, *T. rubbioli*, *T. sandovali* and *T. sketi*) by pectoral-fin ray count reaching 9 branched rays (vs. 6–8); and the first ray of the pectoral fin prolonged as a long filament, except all hypogean *Trichomycterus* (vs. first pectoral fin ray not prolonged or variably extended in all epigean species). *Trichomycterus donascimientoi* can be diagnosed from almost all congeners, excluding *T. sketi* and *T. uisae* by the caudal fin obliquely rounded, with upper portion of caudal fin slightly longer than lower portion (vs. rounded or truncate in the remaining trans-Andean species from Colombia); coloration from homogeneous light-red to pale rose, similar to that reported for troglomorphic species from Colombian cave environments (vs. variably pigmented in epigean trans- Andean species from Colombia and the hypogean *T. sketi* and *T. itacarambiensis*); anterior cranial fontanel connected to the posterior fontanel by an opening of variable length and width except *T. uisae* (vs. fontanels separated by epiphyseal in almost all epigean species).

Trichomycterus donascimientoi can also be differentiated from the only other species described from the same geographic area (La Paz, Santander), *T. sketi*, by the origin of pelvic fin slightly posterior to vertical through the dorsal fin origin (vs. anterior to dorsal-fin origin). *T. donscimientoi* has its first dorsal-fin pterygiophore inserted between the neural spines of free vertebra 13-14, in *T. sketi* it is inserted in free vertebra 17-18, and first anal-fin pterygiophore is inserted between hemal spines of free vertebrae 18-19 (vs. free vertebra 20-21). Also, *Trichomycterus donascimientoi* differs from *T. sketi* by having 24-26 dorsal procurrent caudal-fin rays (vs. 16-18), reduction or loss of the cornea (vs. cornea present) and well-developed troglomorphisms (vs. not developed).

According to Castellanos-Morales *et al.* (2011), the following species of *Trichomycterus* inhabit the Suárez River basin, in the department of Santander, Colombia: *T. bogotensis, T. latistriatus*, *T. sandovali* and *T. straminius*. *Trichomycterus donascimientoi* differs from *T. bogotensis*, *T. latistriatus* and *T. straminius* by well-developed troglomorphisms (vs. not developed) and nine pectoral-fin branched rays (vs. six to eight). Also, *T. straminius* has a rounded caudal-fin edge (vs. obliquely rounded in *T. donascimientoi*). *Trichomycterus bogotensis* and *T. latristiatus* differ from *T. donascimientoi* by the dorsal-fin origin anterior to origin of pelvic fin, (vs. at the same level or slightly anterior to the origin of the pelvic-fin). *Trichomycterus donascimientoi* differs from *T. sandovali* by the presence of eyes (vs. absence), 33-34 free vertebra (vs. 35-36) and dorsal-fin origin after the midpoint of the standard length (before the midpoint of the standard length).

Description. Morphometric data presented in Table 1. Body elongated, deeper than wide, gradually deeper from pectoral region to pelvic-fin

insertion; dorsal profile convex from nape to origin of dorsal fin; ventral profile slightly straight, dorsal and ventral profile of caudal peduncle slightly convex. Thick and pale integument. Head wide, depressed and triangular in dorsal view; dorsal profile of head straight, ventral and lateral profile convex; jaw muscles not particularly developed. Eyes positioned dorsally on anterior half of head, variably reduced in size from well-developed to visible externally as small black spots and slightly covered by integument continuous with head skin. Reduction or loss of the cornea, from well-developed in young specimens to absent in large specimens (66 mm SL or more).

Table 1. Morphometric data for holotype (H) and 12 paratypes of *Trichomycterus donascimientoi*. Standard length (SL) expressed in mm. Measurements 2-10 expressed as percents of SL; Measurements 11 - 19 expressed as percent of head length (HL). M: mean; R: range.

Standard length	H	M	R
	78.0	**-**	**34.2 - 80.0**
Percentage of standard length			
Total length	116.7	117.8	115.8 - 121.0
Body depth	16.7	16.9	15.5 - 19.5
Predorsal length	56.9	56.9	54.7 - 59.7
Prepelvic length	55.4	57.4	55.9 - 60.5
Preanal length	69.0	70.5	67.6 - 73.5
Caudal peduncle length	22.0	22.2	20.7 - 23.9
Caudal peduncle depth	13.5	13,8	13.3 - 14.6
Dorsal-fin base length	10.6	10.7	9.8 - 12.1
Pelvic-fin base length	2.8	2.7	2.2 - 3.0
Head length	19.3	20.2	19.0 - 22.2
Percentage of head length			
Head width	105.5	100.9	93.0 - 108.2
Head depth	61.0	58.7	56.0 - 63.2
Mouth width	47.1	39.1	31.7 - 47.1
Eye diameter	1.9	6.7	1.9 - 11.7
Interorbital width	35.6	33.8	31.6 - 36.3
Nasal barbel length	105.5	124.3	104.6 - 160.2
Maxillary barbel length	102.7	107.7	88.5 - 134.9
Rictal barbel length	72.5	73.0	60.7 - 83.8
Interopercular patch length	15.3	17.0	14.6 - 19.4

Mouth subterminal, with corners oriented backwards. Lower lip with conspicuous fleshy lateral lobes. Anterior nostril ovoid and slightly smaller than posterior one, surrounded by slightly raised thick integument, continuous with nasal barbel. Posterior nostril rounded, oriented transversally, surrounded anteriorly by laterally-folded flap of integument. Teeth conical, slightly straight but curved at the tip, arranged in 3-4 irregular rows on upper jaw and three rows on lower jaw (Figure 2).

Nasal and maxillary barbels surpassing base of pectoral fin. Nasal barbel longer than maxillary barbel. Interopecular patch of odontodes well developed, with 25-29 conical and elongated odontodes, arranged in 4 irregular rows, with large interopercular odontodes on the posterior edge. Opercular patch of odontodes small, with 9-11 conical odontodes arranged in 3 irregular rows.

Neurocranium with elongate mesethmoid T-shaped. Anterior fontanel small, triangular in shape, located between frontals at level of infraorbital canal exit. Posterior fontanel long and connected with anterior fontanel through opening of variable length and width. Anterior one-third of posterior fontanel situated between frontal bones and, anterior portion of parieto-supraoccipital bone (Figure 3). Thicked branchial membranes, united to isthmus anteromedially and forming free fold across isthmus. Gill opening wide. Branchiostegal rays seven (Figure 4), ray 5 with enlarged distal tip, ray 6 surpasses posteriorly ray 5, with distal portion located under ray 5 and covered by interopercle, ray 7 with a medial portion of the ray locate under de rays 6 and 5, reaching ventral margin of opercular patch of

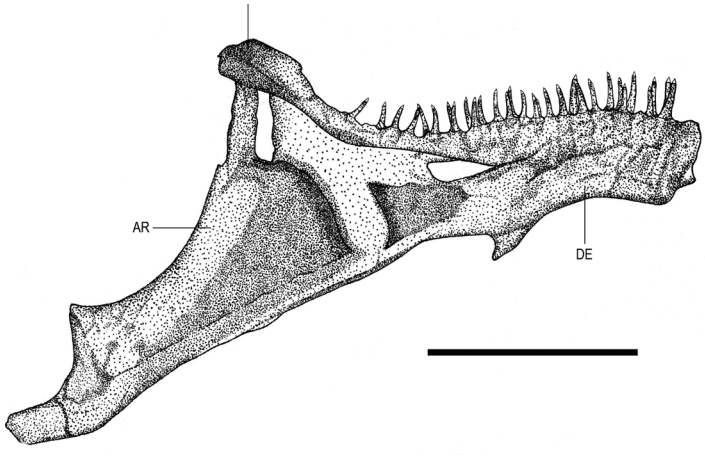

Figure 2. Left lower jaw in medial view of *Trichomycterus donascimientoi*, CAC-CDMB 225, 59.1 mm SL. Abbreviations: AR: anguloarticular ; CP, coronoid process; DE, dentary. Scale bar = 1 mm.

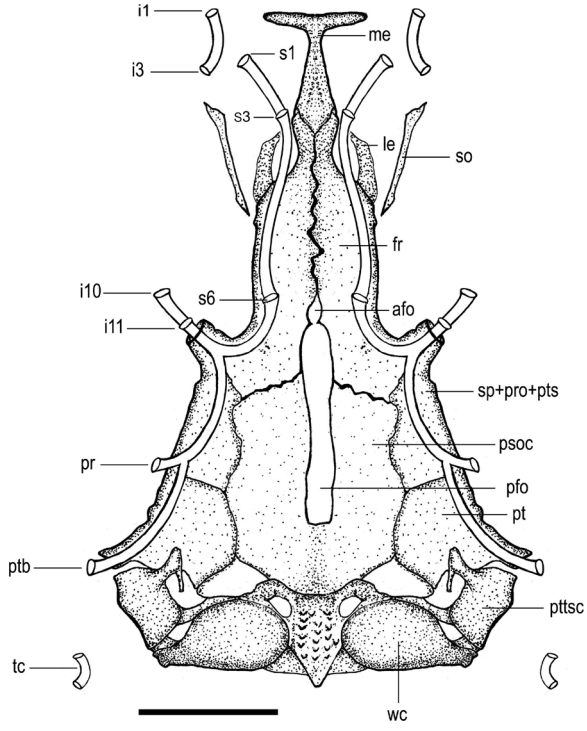

Figure 3. Dorsal view of the neurocranium of *Trichomycterus donascimientoi*. CAC-CDMB 225, 59.1 mm SL. afo, anterior fontanel; i1, infraorbital sensory pore 1; i3, infraorbital sensory pore 3; i10, infraorbital sensory pore 10, i11, infraorbital sensory pore 11; le, lateral ethmoid; me, mesethmoid; pfo, posterior fontanel; pr, preopercular sensory pore; psoc, parieto-supraoccipital; pt, pterotic; ptb, pterotic branch; pttsc, posttemporo-supracleithrum; s1, supraorbital sensory pore 1; s3, supraorbital sensory pore 3; s6, supraorbital sensory pore 6; so,supraorbital tendon bone; sp+pro+pts, sphenotic-prootic-pterosphenoid complex bone; tc, trunk canale; wc, weberian capsule. Scale bar = 2 mm.

odontodes. Urohyal with long, very narrow posterior process, broad convex posterior margin, lateral process with distal margins chipped, hypobranchial foramen slightly ovoid. Hypohyal with depression to which articulates anterior process of urohyal. Head sensory canals with simple tubes. Sensory pore s1 medially adjacent to anterior nostril. s3 medial to posterior nostril. s6 at level of posterior eye. Infraorbital sensory canal with 2 segments, anterior with 2 branches and pores (i1 and i3) and posterior segment with 2 branches and pores (i10 and i11). Preopercular canal short, pore above origin of opercular patch of odontodes. Postotic canal with pore above opercular patch of odontodes.

Pectoral-fin margin rounded with i,9 rays. First ray thin and fragile, prolonged as a long filament. Scapulocoracoid with long anteriorly directed process, located close to first pectoral-fin ray base. Dorsal fin rounded, located slightly anterior to pelvic-fin origin, with ii,6 rays. First dorsal-fin pterygiophore inserted between neural spines of free vertebra 13-14. Pelvic-fin rays i,4, with a lateral splint. Pelvic-fin origin slightly posterior to vertical through dorsal-fin origin and its edge surpasses urogenital opening. Inner margins of pelvic-fin bases slightly separated. Basipterygium with two long anterior processes narrowing from base to distal tip, one or two medial processes and one short posterior process. Anal fin similar to dorsal fin, but smaller, with ii,6 rays, its origin at level of last dorsal-fin ray. First anal-fin pterygiophore inserted between hemal spines of vertebrae 18-19. Caudal-fin edge obliquely rounded. Principal caudal-fin rays 14. Caudal skeleton with neural spine of preural centrum 2 well developed. Hypurals 1 and 2 fused to parhypural, associated with two unbranched rays and seven branched rays; hypural 3 fused to hypural 4, articulating with three branched rays; hypural 5 narrowly separated from hypurals 3+4 for entire length, associated with one unbranched ray and one branched ray (Figure 5). Uroneural with slightly rounded distal tip, not fused to hypural 5. Neural spine 1 of preural centrum reduced to almost 25% of uroneural length, rounded tip projected upward. Dorsal procurrent caudal-fin rays 24- 26, and 14-16 ventral procurrent rays. Free vertebrae 33-34. Ribs 11-12. Anal and urogenital openings closer to anal-fin origin than to pelvic-fin base, totally covered when pelvic fin extended.

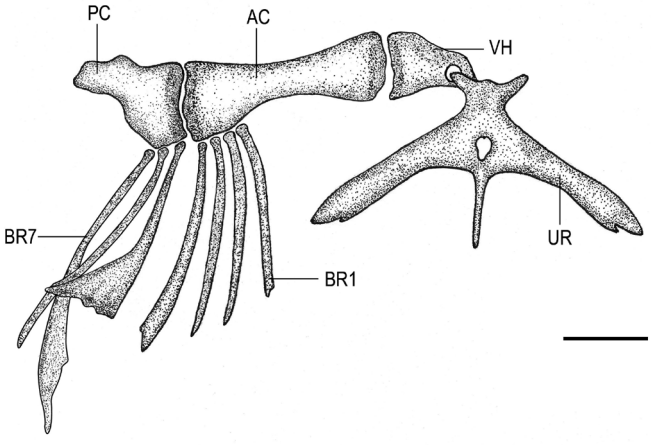

Figure 4. Left hyoid arch of *Trichomycterus donascimientoi* CAC-CDMB 225 59.1 mm SL. Ventral view. Abbreviations: AC, anterior ceratohyal; BR 1 to 7, branchiostegal rays; PC, posterior ceratohyal; UR, urohyal; VH, ventral hypohyal. Scale bar = 1 mm.

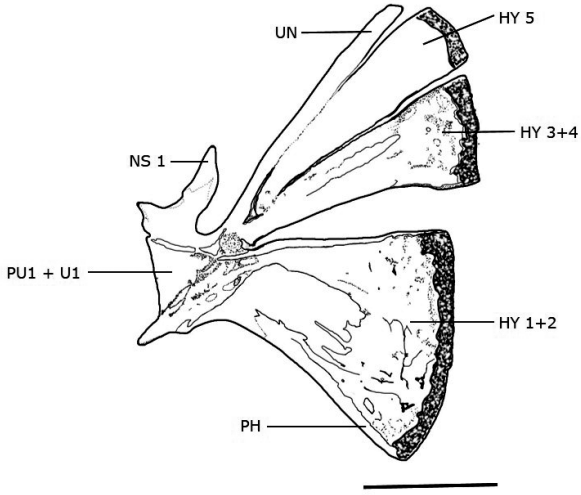

Figure 5. Caudal skeleton of *Trichomycterus donascimientoi*, CACCDMB 225, 57 mm SL. HY: hypurals 1-5; NS 1: neural spines of preural centrum; PH: parhypural; PU1+U1: complex preural centrum 1+ ural centrum 1; UN: uroneural. Scale bar = 1 mm.

Coloration in live specimens. Body color light-brown (**M** 10YR - 5/6). Base of all fins yellow (**M** 5YR – 6/8 to **M** 2.5Y – 7/6).

Coloration in alcohol. All specimens with ground color pale yellow (**M** 5Y - 8/4). Base of all fins yellow (**M** 2.5Y – 7/6).

Distribution. *Trichomycterus donascimientoi* is known exclusively from the hipogean environment of the de Gedania Cave, near to Gran Curí River, in the Magdalena River system, Department of Santander, Colombia.

Ecological data. The de Gedania Cave (also known as del Puya Cave) is located at approximately 6.2 km South from the municipality of La Paz – Santander (Figure 6). This region is on the western flank of the Andean Cordillera Oriental, with lithostratigraphic sedimentary units from the Cretaceous period grouped in different geologic formations as Rosablanca, Paja, Tablazo, Simit,

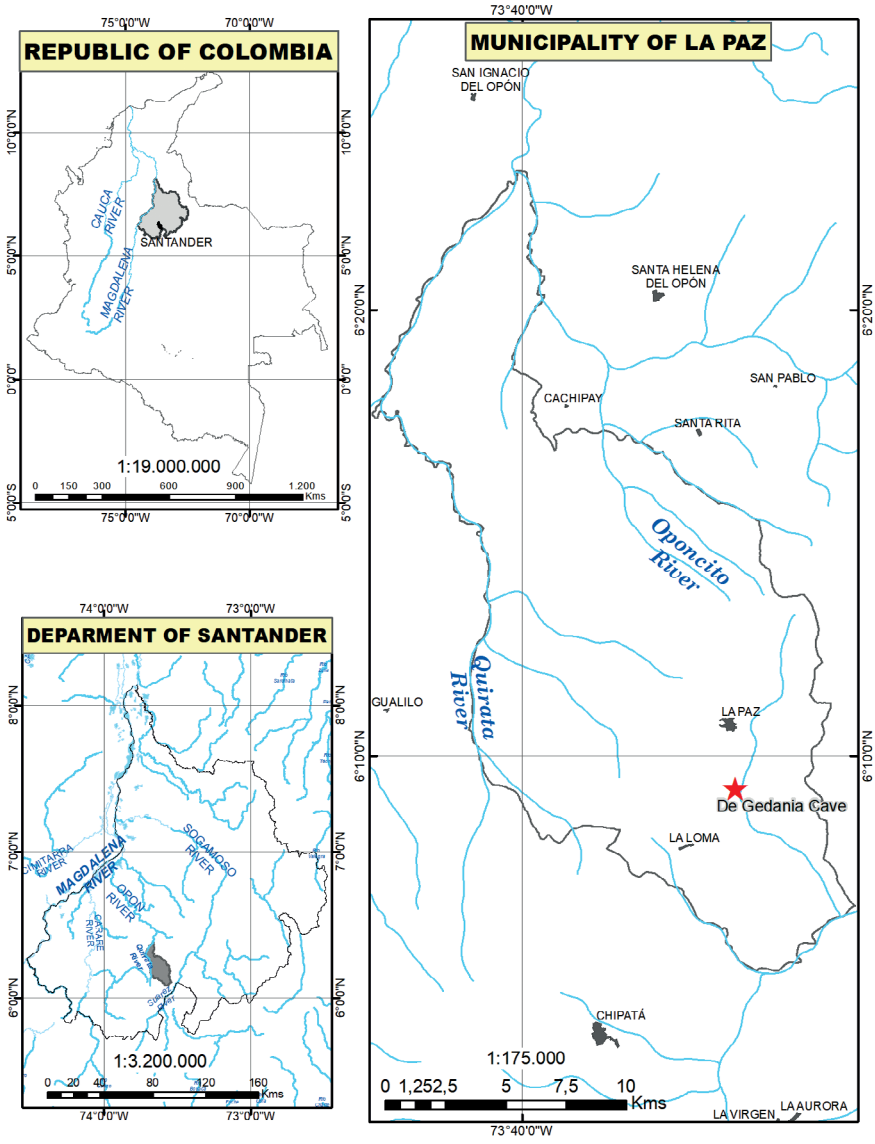

Figure 6. Map of La Paz, northeastern region of Colombia, showing the geogr aphic position of the de Gedania Cave in the town of Casas Blancas. This is the type locality of *Trichomycterus donascimientoi*.

and Luna (Castellanos *et al.*, 2015). The entrance of the cave is oriented horizontally 60° NW, and has a small flow of water that in the period of low rainfalls remains completely dry (Figure 7). The de Gedania cave has three main sections: the first section, here named *Tunnel A*, has a length of 156 m. The height vary inside the tunnel from 0.8 m to up to 3.1 m high and 1.2 to 3.1 m wide. Small wells are interconnected by reduced descending channels along the tunnel. The bottom of each well is rocky and contains abundant fine sediment. The second section has a small gallery called *Gallery A* with an average height of 7 m and 8 m wide. The third section, called *Gallery B*, starts with a waterfall formed by the infiltration process with 50 m high, from which the last gallery, with about 90 m long and up to 20 m high is connected. Specimens of the new species were collected in the first and second sections of the cave, where the water temperature was 17.9°C, cave temperature 18.1°C, and water pH was 6.7. Neither stalagmites nor stalactites, or any kind of incrustation, was recorded inside the cave, (Comisión Polaca, 1977; pers. obs.). The population densities of *Trichomycterus donascimientoi* recorded in three different expeditions were extremely low. The cave is located in an area with livestock and agricultural production such as sugar cane, cocoa, corn and coffee, which use agrochemicals to grow the crops. The deteriorating environmental conditions near the de Gedania Cave, water bodies inside the cave by infiltration process and the low population number of *T. donascimientoi* provide some criteria to consider this species at risk of extinction and a priority in conservation programs. Also, should the species should be included in the Red Data Book for Colombian freshwater fishes. The de Gedania Cave was first explored by the Polish Commission 1975, who named it in honor to the Polish city Gdansk (Comisión Polaca, 1977). Other species that inhabit the interior of the cave include bats (*Carollia perspicillata*), crabs (*Neostrengeria charalensis*), crickets (Phalangopsidae: Phalangopsinae) and aquatic insects (Gerridae, Hemiptera, Heteroptera, Veliidae and Opiliones (cf. Stygnidae) (pers. obs.)).

Etymology. The specific epithet is in honor of Carlos DoNascimiento for his invaluable orientation in my research about the genus *Trichomycterus*. The name is used as an adjective genitive masculine singular.

Common name: Lauchas.

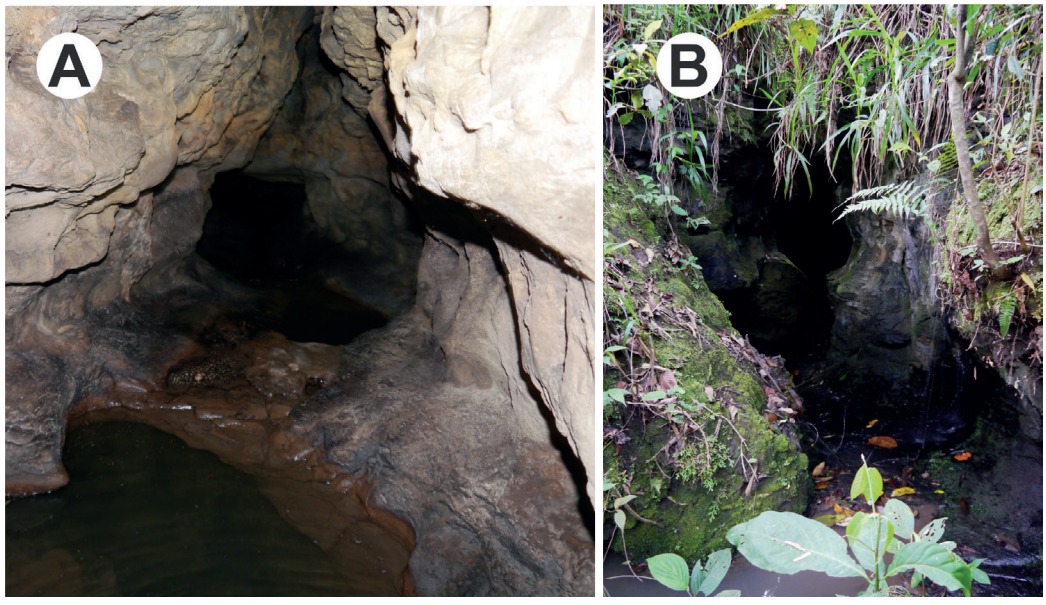

Figure 7. Type locality of *Trichomycterus donascimientoi*. A. inside the de Gedania Cave. B. outside of the de Gedania Cave, middle Suárez River basin, Santander, Colombia.

Discussion

Troglomorphic species are restricted to subterranean environments and exhibit, in variable degrees, the following characters: reduction of eyes, reduced skin pigmentation, and relatively long barbels (Romero & Paulson, 2001; Trajano, 2005; Bichuette & Trajano, 2008; Bichuette & Rizzato, 2012). These characters are very distinctive and well developed in *Trichomycterus donascimientoi*. Three species of *Trichomycterus* restricted to subterranean environments share the above mentioned features with *Trichomycterus donascimientoi*: *T. rubbioli*, *T. santanderensis*, and *T. uisae*. Moreover, *T. dali*, *T. sandovali*, and *T. spelaeus* are species that share the last two characters cited above; however, these species differ from *T. donascimientoi* because they lack eyes.

Trichomycterus donascimientoi exhibits an additional feature that could be related to hypogean life: the extension of the first pectoral fin ray as a long filament which widely surpasses the edge of the pectoral fin (reaching 80% of pectoral-fin length). This condition is also present in all restricted cave fishes of *Trichomycterus*. In all species of the genus the extension of the filament can vary in length from 50% to 95% of the pectoral-fin length of *T. santanderensis* (Castellanos-Morales, 2007). A more comprehensive analysis focusing on this condition in both epigean and hypogean species of *Trichomycterus* should be developed in future studies.

Evolution of troglomorphic characters may be associated with selective pressures which may differ from cave to cave (Culver *et al.*, 1995). In addition to reduction or loss of some structures, many troglomorphic organisms exhibit enhancement of others, particularly those associated with chemical and mechanical sensory systems which are essential for foraging, mating, etc., in the absence of vision (Romero & Green, 2005). Some species from the genera *Trichomycterus* and *Ituglanis* are exclusively hypogean and have elongated barbels that are more developed than those observed in epigean congeners. The enlargement of appendages bearing sensorial structures is broadly recognized as the most common trait characterizing troglobites (Hüppop, 2000; Trajano, 2001). According to Romero & Green (2005) the degree of development of some characters (e.g., barbel elongation in hypogean fishes from families in which barbels are a common characteristic) is conditioned by their phylogenetic history. The new species *Trichomycterus donascimientoi* has very long barbels, especially the nasal and maxillary barbels, which is a remarkable character that can distinguish the species from its epigean congeners and other troglomorphic cave catfishes such as *T. chaberti* and *T. itacarambiensis*, where nasal and maxillary barbel length is shorter than 80% and 90% of HL, respectively.

According to Bockmann & Sazima (2004) the number of pectoral-fin rays has been considered conservative within Trichomycteridae: Trichomycterinae. In this sense, García-Melo *et al.* (2016) showed that the pectoral-fin ray count is a character homoplastically distributed in trichomycterines, *Bullockia* and *Hatcheria* as well as many *Trichomycterus* species have similar number of branched pectoral-fin rays. For this reason, these authors do not discard the potential of this character as informative for several subgroups of Trichomycteridae, including the *Trichomycterus* sensu stricto clade. In *T. donascimientoi* count of pectoral-fin rays reaches i,9, which has been considered by Bichuette & Rizzato (2012) as a rare condition for the genus. Only three cave species (*T sandovali, T sketi* and *T. dali*) and one epigean species (*T. hualco*) share this condition with *T. donascimientoi*. Most *Trichomycterus* species have i,7 pectoral-fin rays, and less commonly i,6 to i,8 pectoral-fin rays.

The cornea is the anterior, transparent window in the collagenous scleral coat of the eyes that contributes to the structural support of the globe, protects the inner eyes from organismal invasion and unwanted environment changes, and helps control intra and extra ocular pressures (Collirt

& Collin, 2001). Although the cornea allows the formation of a sharp image of the external environment that is displayed on the retina, in an aquatic environment the contribution of the cornea to refraction is minimal and does not have an optical use (Land, 1991). In *Trichomycterus donascimientoi* it is observed that eyes have a variable reduction of the cornea from visible and well developed in young specimens to absent in large specimens. When the cornea is absent, eyes are completely sunken in and slightly covered by a continuous integument from head skin. Similar observations have been made in other cave catfishes such as *Rhamdia laticauda*. In adult specimens, the eyes of this species are not visible externally since epidermal parts of the cornea have separated and lost their tight contact. Due to this fact, the eyes are completely sunken beneath the body surface (Wilkens, 2001). Another similar report was made by Castellanos-Morales (2007), in which a cave fish from Colombia, *T. santanderensis,* was observed to have eyes reduced or imperceptible due to covering by thick integument. Reduction in eyes development is a further character associated with troglomorphic species that are restricted to subterranean environments. In this sense, genetic studies conducted by Jeffery (2009) suggest that eye loss is very likely to be adaptive to hypogean environments, due to the energetic cost of maintaining eyes in an environment where they lack utility.

Trichomycterus donascimientoi is an endemic species from La Paz, Santander, Colombia, the same area reported for *T. sketi.* According to Castellanos-Morales (2010), *Trichomyucterus sketi* was described from a subterranean population with not well developed troglomorphic characters. For this reason, the author considered *T. sketi* as an hypogean but not troglobitic species. The colonization of the hypogean environments (de Gedania and del Indio Caves) in the karst area of La Paz, occurred independently for each of these species; the presence of well-developed troglomorphic characters in *T. donascimientoi* is an evidence of the early colonization of subterranean environment of the de Gedania Cave. (vs. late in del Indio Cave).

Comparative material. *Trichomycterus bogotensis*, MLS 25, 3, Colombia: Cundinamarca: Guasca. *Trichomucterus cachiraensis*, CAR 468, 1, Colombia: Norte de Santander. *Trichomycterus latistriatus*, MLS 850, 1, Colombia: Cundinamarca: Machetá. *Trichomycterus sandovali*, CAR 115 paratype, 1, Colombia: Santander. *Trichomycterus santanderensis*, CAC-CDMB 35, holotype, Colombia: upper Lebrija river basin: El Puente Cave. *Trichomycterus sketi*, CAC-CDMB 104, holotype, Colombia: Santander: upper Opón River basin: La Paz: vereda Casas Blancas: Cueva del Indio.*Trichomycterus straminius*, IAvH-P 440, 3, Colombia: Santander: Suárez River basin. *Trichomycterus striatus*, CAC-CDMB 111, 4, Colombia: Santander: Sogamoso River basin: río Chicamocha. *Trichomycterus uisae*, CAC-CDMB 072, holotype, Colombia: upper Sogamoso River basin: El Misterio Cave.

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Literature cited

Ardila-Rodríguez, C. A. (2016). *Cinco nuevas especies de peces Tricomycterus para la region caribe – Colombia.* Barranquilla, Departamento del Atlántico. N.2. 23 pp.

Ardila-Rodríguez, C.A. (2014). *Trichomycterus nietoi sp. nov. (Siluriformes: Trichomycteridae) una nueva especie de pez del río Guachaca, Sierra Nevada de Santa Marta.* Departamento del Magdalena - Colombia, 22 pp.

Bichuette, M. E & Trajano, E. (2008). *Ituglanis mambai*, a new subterranean catfish from a karst area of Central Brazil, rio Tocantins basin (Siluriformes: Trichomycteridae). *Neotropical Ichthyology,* 6 (1): 9–15.

Bichuette, M. E & Rizzato, P. P. (2012). A new species of cave catfish from Brazil, *Trichomycterus rubbioli* sp.n., from Serra do Ramalho karstic area, São Francisco River basin, Bahia State (Silurifomes: Trichomycteridae). *Zootaxa,* 3480 (1): 48–66.

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.

Bockmann, F. A., Casatti, L. & de Pinna, M. C. C. (2004). A new species of trichomycterid catfish from the Rio Paranapanema basin, southeastern Brazil (Teleostei: Siluriformes), with comments on the phylogeny of the family. *Ichthyological Exploration of Freshwaters,* 15: 225-242.

Castellanos-Morales, C. A. (2007). *Trichomycterus santanderensis*: A new species of troglomorphic catfish (Siluriformes, Trichomycteridae) from Colombia. *Zootaxa,* 1541 (1): 49-55.

Castellanos-Morales, C. A. (2008). *Trichomycterus uisae*: a new species of hypogean catfish (Siluriformes: Trichomycteridae) from the northeastern Andean Cordillera of Colombia *Neotropical Ichthyology,* 6 (3): 307-314.

Castellanos-Morales, C. A. (2010). *Trichomycterus sketi*: a new species of subterranean catfish (Siluriformes: Trichomycteridae) from the Andean Cordillera of Colombia. *Biota Colombiana,* 11: 33-41.

Castellanos-Morales, C. A &. Galvis, F. (2012). Las especies del género *Trichomycterus* (Siluriformes: Trichomycteridae) en Colombia. *Boletín Científico Centro de Museos Museo de Historia Natural,* 16: 194-206.

Castellanos-M., C. A., Marino-Zamudio, L. L., Guerrero, L. & Maldonado-Ocampo, J. (2011). Peces del departamento de Santander, Colombia. *Revista de la Academia Colombiana de Ciencias Exactas Físicas y Naturales*, 35 (135): 201-224.

Castellanos-M., C. A., Moreno, F., Malagón, L. M., Arango, A. J., Pardo, D. & Mendez, M. (2015). Aportes al conocimiento y uso de los ecosistemas subterráneos del municipio de La Paz (Santander) *Boletín científico del Centro de Museo, Universidad de Caldas,* 12 (2): 173-185.

Collirt, S. P & Collin, H. B. (2001). The fish cornea: adaptations for different aquatic environments. *Sensory Biology of Jawed Fishes: New Insights,* 57.

Comisión Polaca. (1977). Expedición polaca "Andes 75" *Boletín de la Sociedad Geográfica de Colombia,* 31 (3): 1-18.

Culver, D. C., Kane, T. C. & Fong, D. W. (1995). *Adaptation and Natural Selection in Caves. The Evolution of Gammarus minus*. Cambridge: Harvard University Press. 223 pp.

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 (2): 193-246.

DoNascimiento, C. (2005). Estatus taxonómico y sistemático de la población de bagres tricomictéridos de la cueva del Guácharo (Otophysi, Siluriformes). *Memorias del VII Simposio Colombiano de Ictiología,* Chocó, Colombia. Pp. 44–50.

DoNascimiento, C., Cárdenas-Bautista, C. J. S., Borja, K. G., González-Alvarado, A. & Medina, C. A. (2016). Illustrated and online catalog of type specimens of freshwater fishes in the colección de peces dulceacuícolas of Instituto de Investigación de Recursos Biológicos Alexander von Humboldt (IAvH-P), Colombia. *Zootaxa,* 4171 (3): 401-438.

DoNascimiento, C., Prada-Pedreros, S. & Guerrero-Kommritz, J. (2014). 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.

DoNascimiento, C., Villarreal, O. & Provenzano, F. (2001). Descripción de una nueva especie de bagre anoftalmo del género *Trichomycterus* (Siluriformes, Trichomycteridae), de una cueva de la Sierra de Perijá. Venezuela. *Boletín de la Sociedad Venezolana de Espeleología,* 35: 20-26.

Eschmeyer W. N. & Van der Laan, F. R. (*Eds*). (2017). Catalog of Fishes: genera, species, reference. Retrieved on October 2, 2017 from http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp

García-Melo, L. J., Villa-Navarro, F. A. & DoNascimiento, C. (2016). A new species of Trichomycterus (Siluriformes: Trichomycteridae) from the upper río Magdalena basin, Colombia. *Zootaxa,* 4117 (2): 226–240.

Hüppop, K. (2000). How do cave animals cope with the food scarcity in caves? In Wilkens, H., Culver, D. C. & Humphreys, W. F. (Eds.). Ecosystems of the World, 30: Subterranean Ecosystems. Pp. 159–188. Amsterdam: Elsevier.

Jeffery, W. (2009). Regressive Evolution in *Astyanax* Cavefish. *Annual Review of Genetics,* 43 (1): 25-47

Land, M. F. (1991). Optics of the eyes of the animal kingdom. En JR Cronly-Dillon. *Evolution of the eye and the visual system*. Pp: 118-135. Vision and visual dysfunction.

Lundberg, J. G & Baskin, J. N. (1969). The caudal skeleton of the catfishes, Order Siluriformes. *American Museum Novitates,* 2398: 1-49.

Mattox, G. M. T., Bichuette, M. E., Secutti, S. & Trajano, E. (2008). Surface and subterranean ichthyofauna in the Serra do Ramalho karst area, northeastern Brazil, with updated lists of Brazilian troglobitic and troglophilic fishes. *Biota Neotropica,* 8: 145-152.

Morris, P. J., Yager, H. M. & Sabaj Pérez, M. H. (2006). ACSImagebase: a digital archive of catfish images compiled by participants in the All Catfish Species Inventory. [WWW image Database] Retrieved from http://acsi.acnatsci.org/base

Munsell Soil Color Charts. (1994). Munsell Color Co. Baltimore, MD. 20 pp.

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*. Pp. 279-330. Porto Alegre: Edipucrs, 603 pp.

de Pinna, M. C. C. (1992). *Trichomycterus castroi*, a new species of trichomycterid catfish from the Rio Iguaçu of Southeastern Brasil (Teleostei: Siluriformes). *Ichthyological Exploration of Freshwaters,* 3: 89-95.

de Pinna, M. C. C & Wosiacki, W. B. (2003). Family Trichomycteridae (Pencil or parasitic catfishes). In Reis, R. E., Kullander, S. O. & Ferraris, C. J. (*Eds*.). *Check List of the Freshwater Fishes of South and Central America.* Pp. 270–290. Edipucrs, Porto Alegre, Brazil.

Proudlove, G. S. (2010). Biodiversity and distribution of the subterranean fishes of the world. In Trajano, E., Bichuette, M. E. & Kapoor, B. G. (Eds.). *Biology of Subterranean Fishes*. Pp. 41-63. Enfield, Science Publishers, 480 p.

Romero, A. & Green, S. M. (2005). The end of regressive evolution: examining and interpreting the evidence from cave fishes. *Journal of Fish Biology,* 67: 3–32

Romero, A & Paulson, K. M. (2001). It's a wonderful hypogean life: a guide to the troglomorphic fishes of world. *Environmental Biology of Fishes,* 62: 86-112.

Sabaj, M.H. (2016). Standard symbolic codes for institutional resource collections in herpetology and ichthyology: an Online Reference. Version 6.5 (16 August 2016). Electronically accessible. American Society of Ichthyologists and Herpetologists, Washington, DC. Retrieved from http://www.asih.org/

Trajano. E. (2001). Ecology of subterranean catfishes: an overview. *Environmental Biology of Fishes*, 62: 133–160.

Taylor, W. R & van Dyke, G. G. (1985). Revised procedures for staining and clearing small fishes and other vertebrates for bone and cartilage study. *Cybium,* 9: 107-119.

Trajano, E. (2005). Evolution of lineages. In Culver, D. & White, W. (Eds.). The Encyclopedia of Caves. Pp. 230-234. San Diego, California, USA: Academic Press.

Wilkens, H. (2001). Convergent adaptations to cave life in the *Rhamdia laticauda* catfish group (Pimelodidae, Teleostei). *Environmental Biology of Fishes,* 62: 251-261.

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A new species of cave catfish, genus *Trichomycterus* (Siluriformes: Trichomycteridae), from the Magdalena River system, Cordillera Oriental, Colombia

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Must be clearly included in the text of the manuscript, but not be included in Literature cited section.

Details for Data Papers

A Data Paper is a type of scientific publication that was designed to stimulate the publication of biodiversity data. Data Papers give academic and professional acknowledgement to those who intervene, in one way or another, in the management of information about biodiversity, as well as highlight the existence and importance of data sets to the rest of the scientific community.

As its name suggests, a Data Paper describes a primary data set. Although a Data Paper is not, strictly speaking, a scientific investigation, it must contain relevant information about the data set (objectives, methods for data collection, funding, taxonomic and geographic coverage, etc.), along with its value and utility (basic or applied) for the scientific community (Chavan & Penev, 2011)[1]. The great advantage and novelty of this type of manuscript is that it is linked to the data set through a stable and trustworthy repository, the IPT (Integrated Publishing Toolkit). Also, the data set is supported by metadata also available through the IPT and linked to the Data Paper.

A Data Paper must be submitted only when the linked data are primary and original data that have a temporal and methodological restriction and are available in data aggregators such as SiB Colombia and GBIF. Data must be able to follow the Darwin Core (DwC) standard. Examples of such data sets include:

- Project observations
- Biological collections
- Species lists

[1] Chavan, V. y Penev, L. (2011). The data paper: The mechanism to incentivize data publishing in biodiversity science. *BMC Bioinformatics 2011*, 12(Sup. 15): S2

- Genomic data
- Samples
- Inventories
- Databases
- Functional traits

Data sets that do not comply with the characteristics mentioned above will not be accepted for publication as a Data Paper. Such is the case of compilations of biological records that come from secondary sources (p. e. from published literature).

Preparation of Data Paper (publication of data and creation of manuscript)

Since the purpose of a Data Paper is to describe all available data resources regarding biodiversity, it must always be linked to the data set it describes through an URL or DOI.

Information about how to generate and submit a manuscript in order for it to be considered as a Data Paper by using the tools and publication model of SiB Colombia is found below. It must be noted, however, that *Biota Colombiana* also accepts Data Papers that link to data sets published in other known platforms as long as it is linked to a trustworthy repository and has an IPT link. The parts of a Data Paper manuscript are described in Table 1.

As other types of manuscripts that are submitted to the journal, Data Papers will be reviewed by peers and must comply with the same format specifications, citation norms and use of language. Similarly, Data Papers must also be presented with a cover letter, as mentioned in the present Guidelines for authors. Have in mind that as soon as the manuscript is submitted and under evaluation, described data must be available in a public online repository with an adequate license of use and attribution.

Step 1

Data publication in SiB Colombia

SiB Colombia uses a publication model pased on the IPT as its working tool. Using the IPT, the first version of the manuscript may be generated in rich text format (RTF), based on its associated metadata. This tool is available as long as the data set has been indexed by SiB Colombia and sufficient metadata are linked (more information on publication process of SiB Colombia may be consulted in https://www.sibcolombia.net/).

A. Registration of organisation. To publish through SiB Colombia, your organisation must be registered as a publishing partner. Consult this link to find already registered organisations. If your organisation is not registered, adding an organisation is easy through the Registration Format.

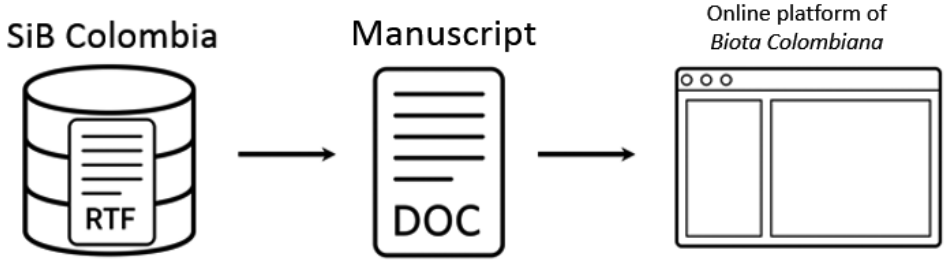

Figura 1. General process to submit a Data Paper from SiB Colombia to the journal *Biota Colombiana.*

B. Data standardization. Data must be structured in a table using the Darwin Core (DwC) standard. Download respective template that is appropriate for type of data or generate your template.

C. Data quality. Data quality must be verified and improved using available tools to identify and correct possible geographical, taxonomic or format errors, among others.

D. Online upload of data. IPT is a tool that shares different types of biodiversity data as long as data is structured using DwC standard. To upload data to the IPT, you must have an existing user account in the available IPT of SiB Colombia. If you do not have an account, you may contact the SiB Colombia Coordinating Team (EC-SiB) and request an account to the email address sib@humboldt.org.co.

E. Data mapping. Once the data set is uploaded, verify that it follows DwC elements. For more information, consult the IPT User Manual or contact EC-SiB.

F. Creation of metadata. Metadata structure is similar to that of a traditional research article. In this way, metadata has the same general structure of a Data Paper and thus facilitate the generation of the manuscript. In the metadata section of the IPT, all information that broadens the context of data must be included. There is a total of 12 sections to add information as metadata to describe the data set. For more information, consult the IPT User Manual or contact EC-SiB.

G. Publish resource and notify EC-SiB. Once all previous instructions are completed, IPT will be activate the "Publish" option. Click on the button and send an e-mail to sib@humboldt.org.co in order to notify EC-SiB about your publication. The e-mail must have as subject "Published resource" and include:

- Name
- Name of organisation
- Name of published resource
- URL of general view of resource after publication

Now data are indexed by SiB Colombia and GBIF, and have a digital object identifier, DOI.

Step 2

Creation of manuscript for submission as Data Paper through IPT

The IPT used for publishing the data set generates a RTF manuscript that describes the data set. The link to the data set in the manuscript appears under the title "Data published through GBIF". Here you will find step by step information about how to generate a manuscript based on the data set metadata published in SiB Colombia.

- On the resource homepage published in IPT, click on the RTF button to download the first version of the manuscript in rich text format, which may be opened in any text processor (p. e. Word) (Figure 2).
- Downloaded manuscript is in English. Necessary corrections to follow *Biota Colombiana* guidelines must be completed on the template. Data Papers template may be downloaded here.
- Once the manuscript is adjusted with additional text, tables and figures, it may be submitted to the journal *Biota Colombiana* through its online platform, following steps of registry as a user. The complete editorial process is developed through this platform.

Step 3

Adjustments and corrections of manuscript for data paper

When a manuscript is submitted as a Data Paper, it will go through the same peer review process as other articles of the journal, with specifications for Data Paper evaluation.

After evaluation, and if the manuscript is accepted, it will be returned to the author with the comments of reviewers and the journal's Editor so that respective modifications may be incorporated.

Figure 2. Metadata of a data set may be downloaded from the IPT as a RTF file, giving the first version of the manuscript that will be submitted to the journal.

As the author, you should do all corrections or modifications directly on the IPT metadata and not on the manuscript. In this way, the metadata of the linked data set are also improved by the peer review and editorial comments.

Once metadata in the IPT are improved, the resource publication must be updated so the changes are reflected. On the resource homepage of the published resource, click on the RTF button to download the improved version of the manuscript in rich text format that may be opened in any type of text processor (p. e. Word).

After the manual changes of additional text, figures and tables, and the corroboration that the manuscript follows all of the journal's requirements, it must be sent again through the online platform of *Biota Colombiana*.

Parts of a Data Paper

Data Papers differ from other articles that are published in the journal *Biota Colombiana* in the sections it should include and are mentioned in Table 1.

Table 1. Structure of a Data Paper and correspondence with GMP elements of IPT.

Name of section	*Correspondence with IPT elements*
Title	Derived from the element *Title*. Centered and without period at the end.
Authors	Derived from the elements *Resource creators*, *Metadata providers* and *Associated Parties*. From the elements, the combination of name and last name, separated by a coma, is created. Author affiliations are indicated with numbers (1, 2, 3…) at the end of each last name with a superscript. Centered.
Affiliations	Derived from the elements *Resource creators*, *Metadata providers* and *Associated Parties*. From these elements, the combination of organisation, address, postal code, city, country and email address constitute the complete affiliation. If one or more authors share the same affiliation, it is represented with the same number.
Contact	Derived from the elements *Resource creators* and *Metadata providers*. From the elements, the combination of name, last name, and email address is created. Email addresses are inside parentheses. If there is more than one author as contact, authors are separated by comas. If the *Resource creator* and *Metadata provider* is the same author, the Resource creator is assumed to be the contact. Text is centered.
Dates of received, revised, accepted and published	Manually incorporated by the editorial assistant of the journal to indicate respective dates of when the manuscript was received, revised, accepted and published as a Data Paper in *Biota Colombiana*.
Abstract	Derived from the element *description*. Abstract must be included in Spanish or Portuguese, and English.
Keywords	Derived from the element *keywords*. Words are separated by comas. Keywords must be written in Spanish or Portuguese, and English.
Introduction	Not derived and must be added by the authors manually.
Taxonomic coverage	Derived from section of taxonomic coverage: *description*, *scientific names*, *common names* and *category*.
Geographic coverage	Derived from section of geographic coverage: *description*, *minimum latitude, maximum latitude, minimum longitude, maximum longitude*.
Temporal coverage	Derived from section of temporal coverage: *description*, *start date, end date*.
Project description	Derived from section of project data: *title, project personnel, funding, study area description, design description.*
Collection data	Derived from section of collection data: *name of collection, collection identifier, parental collection identifier, specimen preservation methods, curatorial units.*
Materials and methods	Derived from section of sampling methods: *study extent, study description, quality control, step description.*
Results	---
Data description	Derived from external links, among others: *name, file URL, file format, version of file format, publication date, language, copyright*. An additional description of data such as text, figures and tables may be added.
Additional information	Derived from element of *additional information.*
Discussion	Not derived and must be added by the authors manually.
Acknowledgements	Not derived and must be added by the authors manually.
Literature cited	Derived from element of *citations*.

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