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A new species of *Loricaria* (Loricariidae: Loricariinae) from the upper Amazon River basin, Colombia

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A new species of *Loricaria* is described from the upper Amazon River basin, Colombia. The new species is distinguished from its congeners primarily by having the dorsal portion of head with uniform black or dark brown coloration extending to three or four plates posterior to dorsal fin base, or with two longitudinal bands from tip of the snout to origin of dorsal fin; abdominal plates tightly joined and completely covering the median abdominal space and pectoral girdle; and pectoral and dorsal fins totally black or dark brown, without bands, spots, or blotches. The new species is further distinguished by plate counts, and body measurements. An analysis of genetic distances using the cytochrome oxidase c subunit 1 marker of the mitochondrial genome showed a clear differentiation between the new species and *Loricaria cataphracta* (5.8–7.6%), *L. nickeriensis* (5.7–6.1%), and *L. simillima* (2.7–7.0%). Species delimitation analyses were carried out, which further supported the new species as a divergent lineage within the genus. Fish species diversity of the upper Amazon River basin and taxonomic issues related to *L. simillima* are included as part of the discussion.

Keywords: COI, Orteguaza River, Putumayo River, Species delimitation analyses.

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Se describe una nueva especie de *Loricaria* de la cuenca alta del río Amazonas, Colombia. La nueva especie se distingue de sus congéneres principalmente por presentar la parte dorsal de la cabeza con un color uniforme negro o marrón oscuro que se extiende a tres o cuatro placas posteriores a la base de la aleta dorsal, o con dos franjas longitudinales desde la punta del hocico hasta el origen de la aleta dorsal; placas abdominales unidas y cubriendo completamente la porción central del abdomen y la cintura pectoral; y aletas pectorales y dorsal completamente negras o marrón oscuro, sin bandas ni manchas. La nueva especie se distingue además por conteos de placas y medidas corporales. Un análisis de distancias genéticas utilizando el marcador de la subunidad 1 del citocromo oxidasa *c* del genoma mitocondrial mostró una clara diferenciación entre la nueva especie y *Loricaria cataphracta* (5,8–7,6%), *L. nickeriensis* (5,7–6,1%) y *L. simillima* (2,7–7,0%). Adicionalmente se realizaron análisis de delimitación de especies, lo que mostró información adicional para reconocer la nueva especie como un linaje divergente dentro del género. La diversidad de especies de peces en la parte superior del río Amazonas y cuestiones taxonómicas relacionadas con *L. simillima* se incluyen como parte de la discusión.

Palabras clave: Análisis de delimitación de especies, COI, Río Orteguaza, Río Putumayo.

INTRODUCTION

Loricaria is the type genus of Loricariidae, described by Linnaeus (1758), with *L. cataphracta* Linnaeus, 1758 as the type species; as currently known, the genus is monophyletic based on morphological evidence (Rapp Py-Daniel, 1997; Thomas, 2011). Through molecular data, Covain *et al*. (2016) found the genus to be paraphyletic, however, maintaining the validity of *Brochiloricaria* Isbrücker & Nijssen, 1979 and *Paraloricaria* Isbrücker, 1979, and revalidating the genus *Proloricaria* Isbrücker, 2001 to render *Loricaria* as monophyletic. The latter hypothesis places the genus in the "*Loricaria* - *Pseudohemiodon* group" along with *Brochiloricaria*, *Crossoloricaria* Isbrücker, 1979, *Dentectus* Martín Salazar, Isbrücker & Nijssen, 1982, *Paraloricaria*, *Planiloricaria* Isbrücker, 1971, *Proloricaria*, *Pseudohemiodon* Bleeker, 1862, *Pyxiloricaria* Isbrücker & Nijssen, 1984, *Reganella* Eigenmann, 1905, *Ricola* Isbrücker & Nijssen, 1978, *Rhadinoloricaria* Isbrücker & Nijssen, 1974, and *Spatuloricaria* Schultz, 1944. Several synonyms of the genus were proposed, as well as the revalidation of genera previously synonymized with *Loricaria* (see Covain *et al*., 2016 for comments on the synonyms). *Loricaria* is diagnosed from other loricariin genera by the following: presence of long, slender (filiform) papillae on the upper and lower lips, and low number of bicuspid premaxillary teeth (usually 3–4 per side) that are twice the length of the dentary teeth (Isbrücker, 1981; Thomas, Rapp Py-Daniel, 2008).

During the last 17 years eight new species of *Loricaria* have been described (Londoño-Burbano *et al*., 2020; Saraiva *et al*., 2021), but an updated taxonomic revision of *Loricaria* has not been published since Isbrücker (1981), who restricted the genus to include 11 valid species. As stated by Londoño-Burbano *et al*. (2020), the discovery and description

of additional species expands our knowledge and understanding of the diversity and distribution of *Loricaria*, but it also demonstrates the need for additional collecting in areas that have been inaccessible and poorly surveyed.

Currently *Loricaria* includes 18 valid species (Fricke *et al*., 2023) distributed in the Amazon, Orinoco, Paraguay, Paraná, and small coastal drainages of Guiana and Brazil (Thomas *et al*., 2013). However, species richness within the genus is poorly known in the upper Amazonas River basin, including several remote areas in Bolivia, Colombia, Ecuador, and Peru; these localities are not easily accessible and few specimens of *Loricaria* have been collected there. Morphological and molecular analyses of specimens recently collected from the Orteguaza River drainage, Putumayo River (upper Amazon River, Colombia), and examination of museum material revealed a new species described herein. We assign the new species to *Loricaria* based on external morphological characters traditionally proposed as diagnostic for the genus.

MATERIAL AND METHODS

Measurements and counts follow Thomas, Sabaj Pérez (2010). Composition of species groups within *Loricaria* follow Thomas, Rapp Py-Daniel (2008) and Thomas, Sabaj Pérez (2010). Measurements were taken point to point with digital calipers (0.1 mm) and were included in tables as percentages of standard length (SL) or head length (HL); holotype data is presented in millimeters (mm). Counts and measurements were taken from the left side of the specimens except when the structure being measured or counted was damaged, in which case data were obtained from the right side. Plate series nomenclature followed Thomas, Rapp Py-Daniel (2008), Thomas, Sabaj Pérez (2010), and Londoño-Burbano, Reis (2019). Posterior lateral plates were examined here as the median series beginning with the first plate on which the dorsal and ventral odontode keels meet and continue parallel to each other to the end of the caudal peduncle. Sexual dimorphism was analyzed following Rapp Py-Daniel, Cox Fernandes (2005). The terms "main cusp" and "lateral cusp" follow Müller, Weber (1992). Characters used to diagnose the new species from congeners not included in "Comparative material examined" were analyzed and compared using original and subsequent descriptions of each species. In the description, counts are followed by their frequency in parentheses, and an asterisk (*) indicates the count of the holotype. Institutional abbreviations follow Sabaj (2020).

Molecular protocols for extraction, amplification, and sequencing of fragments of the cytochrome C oxidase subunit 1 gene (COI) from mitochondrial DNA, editing of sequences, codon visualization, and genetic distances analyses, followed Londoño-Burbano, Britto (2022). Three different species delimitation analyses were carried out. For a Bayesian implementation of the poisson tree processes analysis (bPTP) a Maximum Likelihood (ML) tree was estimated with RAxML PTHREADS-SSE3 implemented in RAxML v. 8.019 (Stamatakis, 2014), with parameters following the autoMRE initialization criteria (as indicated by Pattengale *et al*., 2009) to identify clades (species) by populations. The best-fit evolutionary model (GTR+G) was calculated using the corrected Akaike Information Criterion (AICc) determined by Partition Finder v. 2.1.1 (Lanfear *et al*., 2012). Finally, the best ML tree was used as the input file on the

PTP web server (http://species.hits.org) for delimitation of each operational taxonomic unit (OTU) from each population; the analysis included default parameters. For the General mixed Yule coalescent (GMYC) analysis, an ultrametric tree was estimated using BEAST v. 2.5 (Bouckaert *et al*., 2019). To estimate such tree, a .xml file was created in BEAUti with HKY + G as the best-fit model, a strict molecular clock with clock rate of 1, and the Yule model set as prior for the speciation process; remaining parameters were left as default. Markov Monte Carlo Chains (MCMC) were run for 100 million generations and sampled every 10000th generation. Convergence (ESS value > 200), stability, and appropriate mixing of parameters were verified with Tracer v. 1.7.1 (Rambaut *et al*., 2018); afterwards, a consensus tree was generated with Tree Annotator v. 2.6.7 (Drummond, Rambaut, 2007), with 25% of the trees discarded as burn-in and visualized on FigTree v. 1.4.4 (Rambaut, 2018). GMYC species delimitation was performed with standard parameters [interval = c(0, 10)] and a single threshold, which indicates transition time between to within species branching. This analysis was done through the package splits (Species Limits by Threshold Statistics; http://r-forge.rproject.org/projects/splits) in R v. 4.2.2 (R Development Core Team, 2021). Finally, an Automatic Barcode Gap Discovery (ABGD) analysis was carried out, which according to Puillandre *et al*. (2012) identifies different sequences into potential species based on limits of divergence. Genetic distances were calculated using MEGA 11 (Tamura *et al*., 2021) under Kimura 2-parameter model (Kimura, 1980), to estimate the pairwise genetic distances between species, with 1,000 pseudoreps; that matrix was used as input into the ABGD webserver (https://bioinfo.mnhn.fr/abi/public/abgd/abgdweb.html) and ran using the default parameters set by the portal.

The estimated Extent of Occurrence (EOO) of the species was calculated using the web portal of the Geospatial Conservation Assessment Tool (GeoCAT), defining 1 km^2 grids proposed by Bachman *et al*. (2011). This analysis is focused on the geospatial aspect of Red Listing and the metric is included as part of the categories and criteria of the IUCN (IUCN Standards and Petitions Subcommittee, 2022).

RESULTS

Loricaria nimairaco, new species

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(Figs. 1, 2, 6A, 7, 8, 10; Tabs. 1-4)

Holotype. ICN-MHN 24389, 185.8 mm SL, Colombia, Amazonas, Leticia, río Amazonas, 04°13'29"S 69°56'49"W, 26 Oct 2000, M. Arce.

Paratypes. All from Colombia: ICN-MHN 4492, 6, 115.5–153.1 mm SL, Amazonas, Leticia, Sistema río Amazonas, Laguna Yahuarcaca, Lago 4, 04°11'17"S 69°57'39"W, 13 Jun 1999; ICN-MHN 5212, 4, 123.9–154.5 mm SL, Amazonas, Leticia, km 8 via Leticia-Tarapacá, Yaguarcaca Stream, 04°08'05"S 69°56'36"W, 1 Apr 1999, G Aricari; ICN-MHN 6001, 1, 130.8 mm SL, Amazonas, Leticia, río Amazonas, 04°13'29"S

69°56'49"W, 1 Jul 2000, M. Arce & P. Sánchez; ICN-MHN 9150, 1, 141.5 mm SL, Caquetá, La Montañita, Niña María Stream, tributary of Orteguaza River, 01°22'24"N 75°24'02"W; ICN-MHN 6003, 2, 182.0–182.2 mm SL, same data as holotype; ICN-MHN 9156, 1, 190.9 mm SL, Amazonas, Leticia, sistema río Amazonas, Laguna Yahuarcaca, 04°11'33"S 69°57'28"W, 12 Oct 1999, S. Vejarano; MPUJ 17396, 1, 170.6 mm SL, Putumayo, Puerto Asís, Vereda El Quebradón, río Putumayo, 00°29'43"N 76°21'11"W, 8 Nov 2021, A. Méndez-López, P. Tombé & R. Villota; MPUJ 17397, 1, 155.9 mm SL, Putumayo, Puerto Asís, Vereda Sinaí-Hachapos, Quebrada El Puma, 00°29'48"N 76°22'56"W, 22 Nov 2021, A. Méndez-López, P. Tombé & R. Villota; MPUJ 17398, 1, 104.5 mm SL, Putumayo, Puerto Asís, Vereda Sinaí-Hachapos, Caño Chufiya, 00°29'05"N 76°22'17"W, 26 Aug 2021, A. Méndez-López, P. Tombé & R. Villota; MPUJ 17399, 1, 180.4 mm SL, Putumayo, Puerto Asis, río Putumayo, 00°33'51"N 76°34'31"W, 28 Aug 2021, A. Urbano-Bonilla, A. Méndez-López, G. López Ríos, J. Vásquez, K. Chalial, O. Camacho, R. Villota & W. C. P. Castro; MPUJ 17400, 1, 164.9 mm SL, Putumayo, Puerto Asis, río Putumayo, 00°33'51"N 76°34'31"W, 16 Nov 2021, A. Urbano-Bonilla, A. Méndez-López, G. López Ríos, J. Vásquez, K. Chalial, O. Camacho, R. Villota & W. C. P. Castro; MPUJ 17401, 1, 160.2 mm SL, Putumayo, Villa Garzón, río Guineo, 00°29'22"N 76°31'05"W, 2 Sep 2021, A. Urbano-Bonilla, A. Méndez-López, G. López Ríos, J. Vásquez, K. Chalial, O. Camacho, R. Villota & W. C. P. Castro; MPUJ 17402, 1, 173.1 mm SL, Putumayo, Villa Garzón, río Guineo, 01°01'04"N 76°38'43"W, 1 Mar 2022, A. Urbano-Bonilla, A. Méndez-López, G. López Ríos, J. Vásquez, K. Chalial, O. Camacho, R. Villota & W. C. P. Castro; ROM 107225, 1, 169.6 mm SL, Amazonas, Caquetá, Orteguaza River, 11.4 km SE of Florencia, 01°31'09"N 75°32'19"W, 249 m asl, 7 Aug 2017, N. K. Lujan, A. Ortega-Lara, G. C. Sanchez, C. Conde & V. Meza-Vargas; ROM 107265, 1, 74.8 mm SL, Caquetá, Amazonas River basin, Orteguaza River, 9 km NE of Florencia, 01°39'29"N 75°32'31"W, 272 m asl, 5 Aug 2017, N. K. Lujan, A. Ortega-Lara, G. C. Sanchez, C. Conde & V. Meza-Vargas.

Diagnosis. *Loricaria nimairaco* can be distinguished from all congeners by the following combination of characters: dorsal portion of head to origin of dorsal fin with uniform black or dark brown coloration or the presence of two longitudinal stripes from tips of the snout to origin of dorsal fin, without transversal bands or spots (Figs. 1–2) (*vs*. dorsal portion without coloration, with spots, with transversal bars, or with dark transverse bar reaching nares and snout tip; Figs. 3–5); abdominal plates tightly joined and completely covering the median abdominal space and pectoral girdle (Figs. 1–2) (*vs*. loosely joined, isolated or incompletely covering the pectoral girdle, except species from the *Loricaria cataphracta* group; Fig. 4); and by having dorsal and pectoral fins totally black or dark brown, without bands, spots, or blotches (Figs. 1–2) (*vs*. dorsal and pectoral fins hyaline or with dark bands, spots, or blotches (Fig. 4), except *L. simillima*). The new species is morphologically most similar to *L. simillima*, from which it can be differentiated by counts on total lateral plates 31–33 (modally 32) (*vs*. 34–35, modally 34); anterior lateral plates 17–18 (modally 18) (*vs*. 18–22, modally 20); body width at post-cleithral tip (14.3–17.5% SL *vs*. 10.6–14.7% SL), and presence of a dark vertical band at distal portion of caudal fin occupying less than half of the fin (Figs. 1–2) (*vs*. presence of a solid dark vertical band in posterior portion of caudal fin occupying

almost the entire fin). *Loricaria nimairaco* can be diagnosed from *L. nickeriensis*, which is currently reported as present in the Amazon River, Colombia, by having a broad median abdominal space (Figs. 1–2) (*vs*. abdominal space narrower than width of each adjacent lateral abdominal plate; Fig. 4), presence of plates on cleithral region (Figs. 1–2) (*vs*. absence of plates on cleithral region; Fig. 4), post-orbital notch deep and angular (Fig. 6A) (*vs*. post-orbital notch shallow and rounded; Fig. 6B) and absence of dark blotches on dorsal and ventral portion of body (Figs. 1–2) (*vs*. presence of dark blotches on dorsal and ventral portion of body; Fig. 4).

FIGURE 1 | Holotype of *Loricaria nimairaco*, ICN-MHN 24398, 185.8 mm SL, Colombia, Amazonas, Leticia, Amazonas River. Scale bar = 10 mm. Photos: Gabriel Cortés.

FIGURE 2 | *Loricaria nimairaco*, paratype, MPUJ 17399, 180.4 mm SL, Colombia, Putumayo, Puerto Asís, Putumayo River. Scale bar = 10 mm. Photos: Omar E. Melo-Ortiz.

Description. Measurements are presented in Tab. 1, and general body form is depicted in Figs. 1–2. A medium- to large-sized *Loricaria*, with the largest examined specimen 190.9 mm SL. Head and body depressed; maximum body depth at dorsal fin origin, widest at cleithrum, and becoming attenuate posteriorly. Ventral profile of body straight. Head triangular in dorsal view, with lateral margin from snout tip to opercle straight; dorsum entirely covered with plates, including tip of snout. Postorbital notch well developed and large.

Upper and lower lip covered by long, simple marginal fringe barbels. Filiform papillae on upper lip cover premaxillary teeth. Lower lip with fewer filaments than observed on upper lip. Rictal barbel long and thin, not reaching gill opening, and without secondary branches. Buccal papillae behind premaxillary teeth broader than filaments on lips and longer than premaxillary teeth. Teeth bilobed and slender; main cusp longer than lateral cusp in both premaxillary and dentary teeth; premaxillary teeth longer than dentary teeth. Premaxillary teeth 3(12) or 4*(11), modally 3, and dentary teeth 5(1), 6(6), 7*(8), 8(3), 9(3) or 10(1), modally 7 (see Tab. 2 for meristic comparisons among congeners).

FIGURE 3 | Lectotype of *Loricaria simillima*, BMNH 1880.12.8.77, 163.1 mm SL, Ecuador, Canelos. Photos: Claudio Zawadski, ACSImagebase.

FIGURE 4 | Holotype of *Loricaria nickeriensis*, ZMA-PISC 107561, 116.4 mm SL, Suriname, Nickerie District, Fallawatra River, 5 km south-southwest of Stondansie falls. Photos: Mark Allen, ACSImagebase.

TABLE 1 | Morphometrics of *Loricaria nimairaco* as percentages of standard length or head length; holotype data in mm. Range includes the holotype. N = 23; SD = Standard deviation.

	Holotype	Range	Mean	SD
Standard length	185.8	104.5–190.9	154.5	–
Percents of standard length				
Head length	42.2	20.7–23.7	22.2	0.8
Predorsal length	58.6	29.7–33.7	30.7	1.0
Dorsal spine length	48.8	15.7–27.7	24.7	2.8
Body depth	18.3	9.5–11.3	10.5	0.6
Pectoral spine	40.8	18.1–21.9	20.5	1.2
Pelvic spine length	44.5	17.8–23.4	20.6	1.4
Anal spine length	37.5	16.4–21.3	18.5	1.1
Post-dorsal length	129.2	56.3–69.8	60.4	3.7
Post-anal length	101.5	48.6–58.7	53.3	2.8
Head width	33.2	15.0–19.1	17.2	0.8
Body width at post-cleithral tip	31.6	14.3–17.5	16.0	0.8
Body width at dorsal-spine origin	30.4	12.7–16.0	14.4	0.8
Body width at anal-spine origin	24.0	10.9–12.7	12.1	0.5
Abdominal length	28.5	11.5–18.5	14.1	1.7
Thoracic length	30.5	13.2–17.7	15.7	1.3
Percents of head length				
Snout length	23.1	49.9–57.2	54.3	1.8
Minimum orbital diameter	5.6	12.1–18.4	14.2	1.5
Maximum orbital diameter	7.4	15.3–21.8	19.2	1.7
Head depth	19.7	35.0–59.3	42.8	5.4
Internares width at posterior bony nostrils	2.9	5.0–14.8	7.0	2.9
Nares to orbit at frontal-sphenotic juncture	7.6	14.8–21.2	17.7	1.3
Interorbital width at frontal-sphenotic juncture	9.3	18.4–23.2	19.4	1.3
Orbit at frontal sphenotic juncture to supraoccipital tip	14.8	31.3-43.5	36.5	3.0
Basicaudal plate length	9.9	12.0–27.7	18.5	4.1
Caudal peduncle least depth	2.7	5.8–7.4	6.6	0.5

Abdomen completely covered with small- to medium-sized irregular plates, without any organization in series or rows. Anterior abdominal plates are smaller, almost rounded, and as numerous as central abdominal plates; anterior border of abdominal plates straight to slightly curved, almost reaching the margin of lower lip, and with or without a shallow median notch (Figs. 1–2). Plates absent at pectoral fin insertion. Predorsal region with two closely aligned, well-developed keels, including supraoccipital tip (Figs. 1–2). Three predorsal plates.

Plates in lateral series 31(5), 32*(16) or 33(2). Anterior lateral plates 17(1) or 18*(22) with well-developed keels, with upper and lower series separated. Posterior lateral plates 13(5), 14*(16), 15(1) or 16(1) with series of keels almost joined. Post-anal plates 20(9) or 21*(14). Thoracic plates 8(13) or 9*(10), elongated, and differentiated from those on the rest of abdomen.

Dorsal-fin rays I,7, spine and two first branched rays longest when adpressed; posterior margin of fin straight when extended. Pectoral-fin rays I,6; posterior margin of pectoral fin slightly concave when extended, with spine and first branched ray longer than other rays; most distal tip reaching to almost half the length of pelvic fin when adpressed. Pelvic-fin rays i,5; first ray prolonged, longer than branched rays; posterior margin of fin straight when extended. Anal-fin rays i,5; anal-fin origin is vertically aligned with dorsal fin insertion; posterior margin of fin straight when extended. Principal caudal-fin rays i,10,i; distal margin of caudal fin concave, with upper and lower rays thickened; upper ray is produced into a long trailing filament, which was broken in most specimens examined.

FIGURE 5 | Dorsal, ventral, and lateral view showing coloration and characteristics of *Loricaria simillima*, BMNH 1997.6.26.1-2, 202.3 mm SL. Aquarium specimens. Photos: Lucie Goodayle.

FIGURE 6 | Lateral view of head showing size of post-orbital notch in: **A.** *Loricaria nimairaco*, holotype, ICN-MHN 24398, 185.8 mm SL; and **B.** *Loricaria nickeriensis*, holotype, ZMA-PISC 107561, 116.4 mm SL.

Coloration in alcohol. Ground color tan to dark brown on dorsum and lateral surfaces; ventral unplated surfaces pale; ventral plated surfaces dark yellow; sides of caudal peduncle with subtle dark spots. Dorsum of head and trunk, extending to three or four plates along the dorsal-fin base, dark brown, without spots or bands (Fig. 1); or, with two longitudinal stripes from tips of the snout to origin of dorsal fin, without transversal bands or spots (Fig. 2). Dorsum of trunk posterior to dorsal-fin insertion marked with three or four dark brown transverse bands: just posterior to end of base of dorsal fin, the following band about five plates posterior to the first one, following band about four plates posterior from it, and the last one not reaching caudal-fin origin (Figs. 1–2). Sides of head anterior to opercular opening dark, same as coloration on dorsal portion of head.

Dorsal and pectoral fins entirely black or dark brown, without spots or bands (Figs. 1–2). Pelvic fins either entirely black or dark brown, without spots or bands (Figs. 1–2) or mostly hyaline, with distal tips of rays dark (Figs. 1–2). Anal fin with irregular dark gray or black blotch or band on basal portion of fin (Fig. 1), or blotch absent (Fig. 2; see below for variation in coloration among populations). Caudal fin with dark pigment covering post-ural plates and distal tips of fin, interrupted by pale vertical band (Fig. 1).

TABLE 2 | Meristic frequencies of *Loricaria nimairaco* compared to congeners. N = number of specimens included.

Total lateral plates									
	N		**31**	**32**	**33**	**34**	**35**		
Loricaria cf. *simillima* (Essequibo-Takutu)	13				1	10	2		
Loricaria simillima Amazon (*includes types)	38					23*	15*		
Loricaria cataphracta (Guianas; *includes topotypes)	31			1	7	20*	3		
Loricaria nimairaco (*holotype)	23		5	17*	2				
Total	106								
Anterior lateral plates									
	N		**16**	**17**	**18**	**19**	**20**	**21**	**22**
Loricaria cf. *simillima* (Essequibo-Takutu)	13					2	9	2	
Loricaria simillima Amazon (*includes types)	38				1	12	22*	2	1
Loricaria cataphracta (Guianas; *includes topotypes)	31		1	1*	12*	14*	3		
Loricaria nimairaco (*holotype)	23			1	22*				
Total	106								
Posterior lateral plates									
	N				**13**	**14**	**15**	**16**	**17**
Loricaria cf. *simillima* (Essequibo-Takutu)	13				3	6	4		
Loricaria simillima Amazon (*includes types)	38				2	14*	18*	3	1
Loricaria cataphracta (Guianas; *includes topotypes)	31				1	5	12*	11*	2*
Loricaria nimairaco (*holotype)	23				4	17*	1	1	
Total	106								
Post-anal plates									
	N			**19**	**20**	**21**	**22**		
Loricaria cf. *simillima* (Essequibo-Takutu)	13				10	3			
Loricaria simillima Amazon (*includes types)	38			1	22*	14	1		
Loricaria cataphracta (Guianas; *includes topotypes)	31			5	15*	11			
Loricaria nimairaco (*holotype)	23				10	13*			
Total	106								
Thoracic plates									
	N		**6**	**7**	**8**	**9**	**10**		
Loricaria cf. *simillima* (Essequibo-Takutu)	13			6	6	1			
Loricaria simillima Amazon (*includes types)	38			8	18*	10*	2		
Loricaria cataphracta (Guianas; *includes topotypes)	31		1*	5	16*	6	3*		
Loricaria nimairaco (*holotype)	23				14	9*			
Total	106								

Sexual dimorphism. Male specimens exhibited thickened pectoral spines (Fig. 7); however, contrary to what is reported in other *Loricaria* species, modifications to lip and barbel morphology (Isbrücker, 1981) were not observed in specimens examined.

Geographical distribution and habitat. *Loricaria nimairaco* is known from the Orteguaza River, the main tributary of the Caquetá River basin, an Andean River draining into the upper portion of the Amazon River, the Putumayo River, and from the Amazon River at Leticia, Colombia (Fig. 8). According to field notes from ROM archives (obtained thanks to N. K. Lujan), one of the specimens (ROM 107225) was captured in high current, over predominantly mud substrate with organic matter. In

contrast, a small specimen (ROM 107265) was collected in a presumably lower gradient stream in slow current, where the bottom was predominantly cobble mixed with sand, with organic matter.

FIGURE 7 | Dorsal view of *Loricaria nimairaco* male, showing a slightly hypertrophied pectoral spine indicating sexual dimorphism, paratype, ICN-MHN 9156, 190.9 mm SL, Colombia, Amazonas, Leticia, Amazonas River system, Laguna Yahuarcaca. Photo: Alexander Urbano-Bonilla.

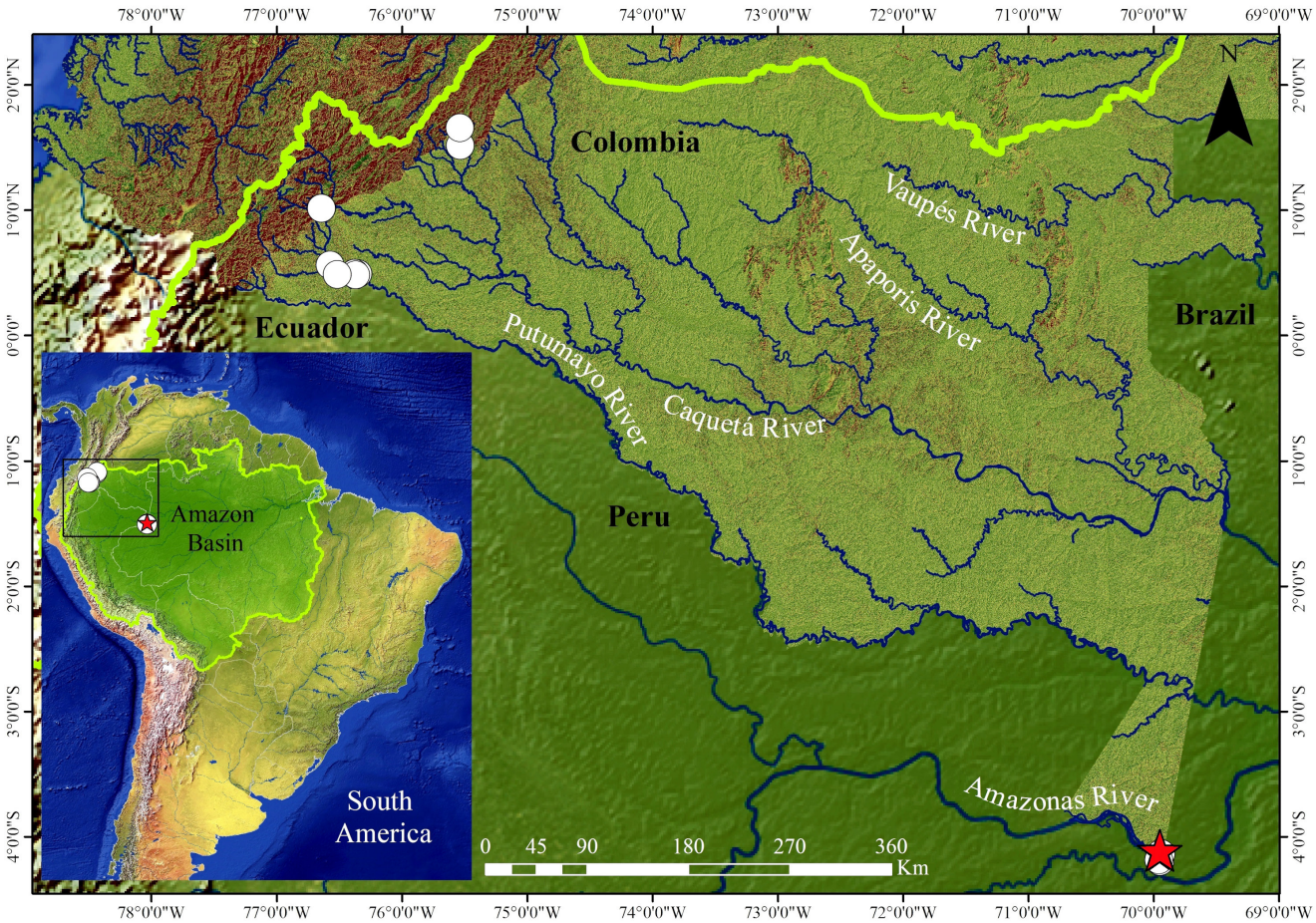

FIGURE 8 | Distribution map of *Loricaria nimairaco*. Red star indicate holotype locality, and white circles indicate paratype localities. Each symbol may represent more than one lot or locality.

Etymology. The specific name *nimairaco* [nɨmâìraco] in the Uitoto-Muinane language from Peru, means "*house of a wise man*" (Minor, Hendrich-Minor, 2008:86). In tribute to our friend and colleague, José Iván Mojica, late professor of the Instituto de Ciencias Naturales de la Universidad Nacional de Colombia. His contributions to Colombian ichthyology (biology, ecology, systematics, and biogeography of freshwater fishes) have made it possible to advance in the conservation of the country's fishes and rivers, such as the Amazon, the river that was always the home of the wise. A noun in apposition.

Conservation status. *Loricaria nimairaco* is found in drainages of the Andean piedmont of the Amazon and upper Amazon (Fig. 8) at nine localities in three basins of Colombia, in the Orteguaza (3), Putumayo (1), and Amazon River (5). Aspects such as increasing rate of deforestation of the watersheds, gold mining activities, cattle ranching, and oil exploitation projects occur in the region where the species is recorded (Ayram *et al*., 2020; Clerici *et al*., 2020) representing a threat to the species; thus, monitoring of the populations should be implemented. Such monitoring programs and decision-making by environmental authorities (*i.e*., Corporaciones Autónomas Regionales-CAR) are currently advancing in the ordering and management of the country's hydrographic basins, established by decree 1729 of 2002. The geographic distribution (83,689.5 km^2) represented as EOO (EOO = B1) categorizes the species as Least Concern (LC) according to the IUCN Subcommittee on Standards and Applications (IUCN 2022).

Color variation within *Loricaria nimairaco* from the Putumayo River. Specimens were collected in the Piedmont and lowland ecoregions of the Putumayo River basin from main river channels, floodplain forest, and Terra-firme streams (Figs. 9A–C). Specimens captured at those localities showed some differences from populations present at the Orteguaza River, and along the upper Amazon River (Colombia). The main difference was the coloration of the dorsal portion of the head (Fig. 2) from specimens from the Orteguaza and Amazon River (at Leticia); individuals from the Putumayo River have two dark longitudinal stripes from the tip of the snout to the predorsal plates (Fig. 2).

FIGURE 9 | Environment at Putumayo River basin. **A.** Piedmont drainages "río Guineo"; **B.** Main channel of the Putumayo River in the lower part; and **C.** Streams of Terra-firme. Photos: Alexander Urbano-Bonilla.

Furthermore, the anal fin lacked dark pigmentation (Fig. 2) in contrast to populations of the Orteguaza River and around Leticia, which exhibits a dark spot near the base of the anal fin (Fig. 1). Meristic counts and measurements show some overlap with those of *Loricaria simillima* Regan, 1904 and totally overlap with what was identified as the new species here (Tab. 2); however, the new species and *L. simillima* can be differentiated by external morphology (see Diagnosis), meristic counts (Tab. 2), and molecular evidence (see Tab. 3; **S1, S2**, **S3**). At present, molecular data are unavailable to assess the identity of populations in the Putumayo River, and further efforts should be made to include samples from that locality in future molecular analyses of the species.

Genetic differentiation and species delimitation. Genetic distances (Tab. 3) were calculated between *Loricaria nimairaco* and morphologically similar, and geographically closely related species, which were used for the ABGD analysis (see below). *Loricaria nimairaco* is most closely related to *Loricaria* cf. *simillima* from the upper Amazon River in Peru (Fig. 10) and form a cluster as the next divergent branch to the remaining *Loricaria* species included here (Genbank records from Pereira *et al*., 2013; Tab. 4). *Rhadinoloricaria* is divergent from *Loricaria*, followed by *Spatuloricaria caquetae* (Fowler, 1943) as the next divergent node to that cluster, and *Rineloricaria* cf. *lanceolata* (Günther, 1868) as divergent from (*Spatuloricaria* (*Rhadinoloricaria* + *Loricaria*)) (Fig. 10).

TABLE 3 | Pairwise mtDNA genetic distance values for COI gene between and within species using a Kimura 2 Parameter. Bold values indicate distances > 2% between new species and congeners.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
*Loricaria_nimairaco*_OP407978																						
*Loricaria_nimairaco*_OP407977	0.00																					
*Loricaria_cataphracta*_MZ052016.1	**0.06**	**0.06**																				
*Loricaria_cataphracta*_MZ051968.1	**0.06**	**0.06**	0.00																			
*Loricaria_cataphracta*_MZ051232.1	**0.06**	**0.06**	0.00	0.00																		
*Loricaria_cataphracta*_MZ050922.1	**0.06**	**0.06**	0.00	0.00	0.00																	
*Loricaria*_sp._Paraguay_OP407986	**0.06**	**0.06**	0.00	0.00	0.00	0.00																
*Loricaria*_cf._*cataphracta*_OP407979	**0.07**	**0.08**	0.01	0.01	0.01	0.01	0.01															
*Loricaria*_cf._*cataphracta*_OP407980	**0.07**	**0.07**	0.01	0.01	0.01	0.01	0.01	0.01														
*Loricaria*_cf._*cataphracta*_OP407981	**0.06**	**0.06**	0.01	0.01	0.01	0.01	0.01	0.00	0.01													
*Loricaria*_cf._*cataphracta*_OP407982	**0.06**	**0.06**	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00												
*Loricaria*_cf._*cataphracta*_KP772582.1	**0.06**	**0.06**	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.00											
*Loricaria*_aff._*nickeriensis*_MZ051209.1	**0.06**	**0.06**	0.03	0.03	0.03	0.03	0.03	0.04	0.03	0.04	0.04	0.04										
*Loricaria*_aff._*nickeriensis*_MZ051100.1	**0.06**	**0.06**	0.03	0.03	0.03	0.03	0.04	0.05	0.04	0.04	0.04	0.04	0.00									
*Loricaria*_aff._*nickeriensis*_MZ051588.1	**0.06**	**0.06**	0.03	0.03	0.03	0.03	0.03	0.04	0.03	0.04	0.04	0.04	0.00	0.00								
*Loricaria*_aff._*nickeriensis*_MZ051111.1	**0.06**	**0.06**	0.03	0.03	0.03	0.03	0.03	0.04	0.03	0.04	0.04	0.04	0.00	0.00	0.00							
*Loricaria*_aff._*nickeriensis*_MZ051265.1	**0.06**	**0.06**	0.03	0.03	0.03	0.03	0.03	0.04	0.03	0.04	0.04	0.04	0.00	0.00	0.00	0.00						
*Loricaria*_aff._*nickeriensis*_MZ051906.1	**0.06**	**0.06**	0.03	0.03	0.03	0.03	0.03	0.04	0.03	0.04	0.04	0.04	0.00	0.00	0.00	0.00	0.00					
*Loricaria*_cf._*simillima*_MK861710.1	**0.03**	**0.03**	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06				
*Loricaria_simillima*_OP407983	**0.06**	**0.06**	0.07	0.07	0.07	0.07	0.07	0.07	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.06			
*Loricaria_simillima*_OP407984	**0.05**	**0.05**	0.03	0.03	0.03	0.03	0.02	0.04	0.03	0.03	0.03	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.05	0.10		
*Loricaria_simillima*_OP407985	**0.05**	**0.05**	0.03	0.03	0.03	0.03	0.02	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.05	0.11	0.00	

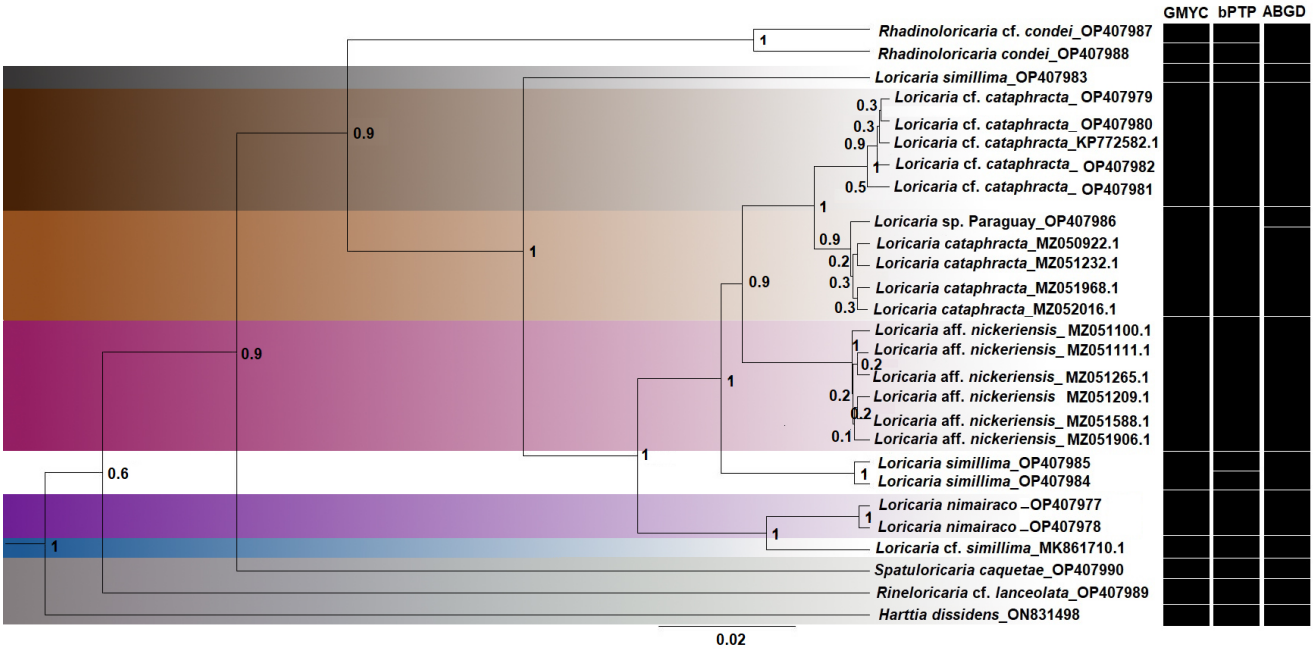

FIGURE 10 | Bayesian GMYC tree of a 591 bp alignment of the mitochondrial COI (cytochrome C oxidase subunit 1 gene) marker. Color boxes indicate taxonomic assignments found through all species delimitation analyses; lineages without color were not recovered on all analyses. Number on nodes corresponds to posterior probabilities (PP). GMYC = General mixed Yule coalescent method; bPTP = Bayesian implementation of the poisson tree processes; ABGD = Automatic Barcode Gap Discovery.

Sequences identified as *Loricaria* aff. *nickeriensis* were obtained from Genbank (Tab. 4) from Papa *et al*. (2021), including fishes from the Maroni River (close to the type locality of the species, see Discussion below). It was found that between *L. nimairaco* (n = 2) and *L.* cf. *nickeriensis* (n = 6; not the one referred to by Galvis *et al*., 2006) the distances are between 5.7–6.1% of genetic divergence, showing a clear differentiation between both species. This also further supports that what was identified by Galvis *et al*. (2006) as *L. nickeriensis*, does not belong to the latter, and is maintained here as *Loricaria* sp. until further data are available; thus, *L. nickeriensis* is not present in Colombia.

The new species is morphologically more similar to *L. simillima*, a species considered widespread in the Amazon River basin (upper, middle, and lower portions), La Plata and Orinoco River basin. We compared the new species to four samples identified as *L. simillima*. As shown in Fig. 10, *Loricaria* cf. *simillima*_MK861710.1 is the most next divergent node to the *L. nimairaco* lineage, indicating close relationship, or belonging to the same species. However, we maintained the former as *L.* cf. *simillima* for two main reasons. First, we did not examine vouchers of the samples included in Genbank (MK861710.1) from a study of fishes in the Peruvian Amazon (according to Genbank records, Tab. 4, from an unpublished study). Secondly, the samples of the new species and *L.* cf. *simillima* are 2.7–3.0% divergent (Tab. 3), indicating species-level differentiation (see below for a discussion). A sample from the Pastaza River, upper Amazon, Ecuador, close to the type locality of *L. simillima* (Canelos, Ecuador), was included for comparison (Tab. 4; see below for a discussion). From that sample the new species showed a divergence of 6.0–7.0%, indicating species-level differentiation

TABLE 4 | Vouchers used in DNA extractions, amplification, and sequencing for genetic distances of COI mtDNA and species delimitation analyses. N/A = Not applicable.

Species	Catalog number	Voucher specimens	Collection data	GenBank Accession number
Harttia dissidens	MPEG 16690	t035	Brazil, Pará, Tocantins River basin, just downstream of BR-150 bridge, NE of Marabá, 05°18'42"S 49°04'24"W	ON831498
Loricaria nimairaco	ROM 107225	T-24758	Colombia, Amazonas, Caquetá, Orteguaza River, 11.4 km SE of Florencia, 01°31'09"N 75°32'19"W, 249 m asl	OP407977
Loricaria nimairaco	ROM 107265	T-24827	Colombia, Amazonas, Caquetá, Amazonas River basin, Orteguaza River, 9.0 km NE of Florencia, 01°39'29"N 75°32'31"W, 272 m asl	OP407978
Loricaria cataphracta	N/A	GF06-470	French Guiana, St-Laurent-du-Maroni, Saint-Laurent du Maroni, Maroni River, Voltaire Creek	MZ052016.1
Loricaria cataphracta	N/A	GFSU12-209	French Guiana, St-Laurent-du-Maroni, Saint-Laurent du Maroni, Maroni River, Serpent Creek	MZ051968.1
Loricaria cataphracta	N/A	GF10-031	French Guiana, St-Laurent-du-Maroni, Saint-Laurent du Maroni, Maroni River, Serpent Creek	MZ051232.1
Loricaria cataphracta	N/A	GFSU12-208	French Guiana, St-Laurent-du-Maroni, Saint-Laurent du Maroni, Maroni River, Serpent Creek	MZ050922.1
Loricaria cf. *cataphracta*	MCP 51676	MCP 51676	Brazil, Pará, Santarém Tapajós River at Ponta do Jari, inside mouth of major whitewater channel discharging rio 02°21'34"S 54°54'38"W	OP407979
Loricaria cf. *cataphracta*	MCP 51629	MCP 51629	Brazil, Pará, Paraná Carareacá, south bank Amazonas River (within 500 m of entrance), 02°10'55"S 54°52'45"W	OP407980
Loricaria cf. *cataphracta*	MCP 52212	MCP 52212	Brazil, Pará, Santarém Amazonas River at the mouth of Lago do Tucumatuba; on the south margin of the main channel 02°14'07"S 54°48'13"W	OP407981
Loricaria cf. *cataphracta*	MCP 52233	MCP 52233	Brazil, Pará, Óbidos, Amazonas River at Santa Rita; on the south margin of the main channel of the river; approximately 120 km upstream to Santarém, 02°02'34"S 55°24'34"W	OP407982
Loricaria cf. *cataphracta*	N/A	INPA 43893	Brazil, Amazonas, Nhamunda River	KP772582.1
Loricaria aff. *nickeriensis*	N/A	GFSU14-324	French Guiana, St-Laurent-du-Maroni, Upper Maroni, Marouini River, Langa Soula	MZ051209.1
Loricaria aff. *nickeriensis*	N/A	GFSU14-125	French Guiana, St-Laurent-du-Maroni, Upper Maroni, Marouini River, Saut Wayo	MZ051100.1
Loricaria aff. *nickeriensis*	N/A	GF15-378	French Guiana, Maripasoula, Maroni River, Cayode, Tampok River, tributary of Lawa River	MZ051588.1
Loricaria aff. *nickeriensis*	N/A	GF00-120	French Guiana, Maripasoula, Marouini River, Antecume Pata	MZ051111.1
Loricaria aff. *nickeriensis*	N/A	GF00-098	French Guiana, Maripasoula, Tampok River, Saut Pierkuru	MZ051265.1
Loricaria aff. *nickeriensis*	N/A	GF00-097	French Guiana, Maripasoula, Tampok River, Saut Pierkuru	MZ051906.1
Loricaria cf. *simillima*	N/A	IIAP-CIIAP-01186-1	Peru, Amazonas River basin	MK861710.1
Loricaria simillima	ROM uncatalogued	ROM T-28093	Ecuador, Amazonas River basin, Pastaza River	OP407983
Loricaria simillima	MCP 46182	MCP 46182	Brazil, Roraima, Caroebe Jauaperi River, at neighboring road 5 approx. 10 km of BR-210, 00°54'47"N 59°34'23"W	OP407984
Loricaria simillima	MCP 46205	MCP 46205	Brazil, Roraima, Rorainópolis, Jaburu Stream, at neighboring road of BR-174 between Jundiá and Rorainópolis, 00°37'15"N 60°31'05"W	OP407985
Loricaria sp. Paraguay	MCP 36566	MCP 36566	Brazil, Mato Grosso, Poconé, Paraguay River basin, stream on left margin at BR-070 to Poconé, at km 74, 16°13'24"S 56°37'36"W	OP407986
Rhadinoloricaria cf. *condei*	ROM uncatalogued	ROM T-28057	Ecuador, Amazonas River basin, Pastaza River	OP407987
Rhadinoloricaria condei	ROM uncatalogued	ROM T-28747	Ecuador, Amazonas River basin, Napo River	OP407988
Rineloricaria cf. *lanceolata*	ROM 107222	ROM T-24755	Colombia, Amazonas, Caquetá, Orteguaza River, 11.4 km SE of Florencia, 01°31'09"N 75°32'19"W, 249 m asl	OP407989
Spatuloricaria caquetae	ROM 107812	ROM T-24934	Colombia, Putumayo, Amazonas River basin, Caquetá River, 12.4 km SE of Mocoa and upstream of Puerto Limón, confluence with La Paujila Stream, 01°03'31"N 76°33'12"W, 319 m asl	OP407990

(Orteguaza River *vs*. Pastaza River). Two additional samples from the Amazon River basin, Brazil (MCP 46182 and MCP 46205) were 4.8–5.1% divergent from the new species (see below for a discussion). These results indicate taxonomic differentiation between what is considered *L. simillima* (in this case from the Amazon River in Brazil, Ecuador, and Peru) and the new species from the Andean localities in the upper Amazon River basin in Colombia.

Further comparisons were made with samples identified as *Loricaria cataphracta*, *L.* cf. *cataphracta*, and an unidentified species of *Loricaria* from the Paraguay River (*Loricaria* sp. Paraguay). We analyzed four samples identified as *L. cataphracta* from Genbank (Tab. 4), all from the Maroni River (Papa *et al*., 2021). The new species was 6.0% divergent from *L. cataphracta*, the type species of the genus. It is worth noting that the samples from the Maroni River are close to the type locality of *L. cataphracta* in the coastal rivers of Suriname. *Loricaria* sp. Paraguay (Paraguay River basin; MCP 36566) is related to the cluster formed by samples of the former (Fig. 10) indicating a relationship between both populations; that result was also obtained by Covain *et al*. (2016: fig. 7) from samples from the same basin. The new species is 5.8% divergent from the unidentified *Loricaria*, indicating taxonomic differentiation. Five samples identified as *L.* cf. *cataphracta* (Tab. 4; unpublished study) from the lower Amazon River basin, near Santarém, Pará State, were 6.5–7.6% divergent from the new species.

bPTP analysis supported *Loricaria nimairaco* as a different lineage (species) from the remaining *Loricaria* included here (Fig. 10 and **S1**), including divergence from *Loricaria* cf. *simillima* MK861710.1, which is more related to the former. The same result was obtained through GMYC (**S2**) and ABGC (**S3**) (Fig. 10). Through species delimitation analyses included here, there were only three differences: bPTP found *L. simillima* OP407984 and OP407985 as different species (Fig. 10; **S1**), while GMYC and ABGC found them as a single lineage (Tab. 3; **S2**); on the other hand, through bPTP and GMYC, *Rhadinoloricaria condei* OP407988 and *Rhadinoloricaria* cf. *condei* OP407987 were found as separate species (Fig. 10; **S1–S2**); ABGD found *Loricaria* sp. Paraguay as a separate lineage from *L. cataphracta* (**S3**). Thus, the main target of the present study, *L. nimairaco*, was invariably found as a different species further supporting the presence of a new species at the upper Amazon River in Colombia.

DISCUSSION

The taxonomic history of *Loricaria*, the type genus of Loricariidae, has always been complicated with up to approximately 100 valid species previously assigned to the genus (Isbrücker, 1981). Apart from that study, several genera were described, mainly by Isaäc Isbrücker and Hans Nijssen (see Isbrücker, 1980; Ferraris, 2007; Covain *et al*., 2016; and Londoño-Burbano, Reis, 2021 for an account of Loricariinae) updating the taxonomy not only of *Loricaria* but of the subfamily as well. The authors used mostly external morphology, organization of abdominal plates, and coloration for the diagnoses and differentiation of the new genera proposed. Within *Loricaria*, Isbrücker (1981) used these characteristics to diagnose species, for example, having a naked abdomen, and either partially or entirely covered by plates (or scutelets); according to the author, the development of such a pattern can be variable with age (see also Londoño-Burbano *et*

al., 2020). In recent descriptions of new species, these characters have had diagnostic utility. For example, Thomas *et al*. (2013) proposed that *Loricaria* species that have a naked cleithral region are distributed south of the Amazon basin, excluding *L. lundbergi* Thomas & Rapp Py-Daniel, 2008 and *L. pumila* Thomas & Rapp Py-Daniel, 2008; such exclusion is corroborated once again here through the description of *Loricaria nimairaco*. As shown in Figs. 1–2 and in the description above, the new species has a completely plated cleithral region. If consistent, the geographic distribution of such characters could indicate a phylogenetic signal; however, a comprehensive morphological, phylogenetic study of the genus is lacking.

Loricaria nickeriensis is a species described from the Fallawatra River, 5 km south-southwest of Stondansie Falls, Nickerie District (Isbrücker, 1979). The species was characterized by having a small adult size, with sexual dimorphism exhibited mainly through thickening of the pectoral-fin spine, and dorsal coloration of anterior portion of body (mainly the head) with dark spots or blotches (Isbrücker, 1979; Fig. 4). *Loricaria nimairaco* can be easily distinguished from *L. nickeriensis* by having a broad median abdominal space (*vs*. abdominal space narrower than width of each adjacent lateral abdominal plates), presence of plates on cleithral region (*vs*. absence of plates on cleithral region), post-orbital notch deep and angular (*vs*. post-orbital notch shallow and rounded) and absence of dark blotches on dorsal and ventral portion of body (*vs*. presence of dark blotches on dorsal and ventral portion of body). As mentioned above, Galvis *et al*. (2006) reported *Loricaria* cf. *nickeriensis* from the Orteguaza River, Caquetá River basin, Colombia; however, the authors did not offer characters used to identify the species. The authors did provide a drawing of the anterior ventral portion of the body detailing the distribution of abdominal plates and lip morphology (see fig. 203 in Galvis *et al*., 2006). The figure clearly shows plates covering the cleithral region, which is not a characteristic found in *L. nickeriensis* (Fig. 4) further indicating a distinct species in the Orteguaza River and upper Amazon River basin in Colombia. Finally, the authors included two photos (dorsal and ventral view) of a specimen, without a catalog number or SL, with less developed plates on the cleithral region but with a pigment pattern not characteristic of *L. nickeriensis* or *L. nimairaco* (see Galvis *et al*., 2006:520, plate 95a). The different pattern of the specimen described by the authors could be based on a live individual; when fixed and preserved, the color could darken, resembling the condition observed here for the new species. However, this is impossible to determine confidently with the data at hand; thus, we identify this specimen as *Loricaria* sp., until additional information is available, but corroborate the absence of *L. nickeriensis* in Colombia.

Loricaria nimairaco is morphologically similar to *L. simillima*, a species currently considered widespread with a confusing taxonomic identity. Regan (1904) described the species from the Pastaza River at Canelos, Ecuador, a locality in the Midwest region of the country, with influence of the Pastaza River, probably from the Marañón River as type locality. The author did not assign a type specimen for the species, offering a very general and short description without apparent unique characters within *Loricaria*. Isbrücker (1979) designated a lectotype and paralectotypes for the species. Thus, the very general description and the absence of type specimens for more than 70 years could have contributed to the confusion surrounding the species. During that time *L. simillima* was included in several taxonomic lists by region, some of them, without direct examination of the specimens but from catalog records (see Thomas, 2011; Londoño-

Burbano *et al*., 2020 for an account). This practice led to the species being recorded as present in the Amazon, Orinoco, and La Plata River basins (Argentina, Brazil, Colombia, Bolivia, Uruguay, Ecuador, Paraguay, Peru, and Venezuela; Fricke *et al*., 2023). The lack of unique diagnostic characters for *L. simillima* has resulted in that name being applied to many *Loricaria* specimens, given their conserved morphology; however, *L. nimairaco* can be differentiated by *L. simillima* based on characters presented above in the diagnosis and genetic distances (Tab. 3). Morphological differentiation coupled with genetic divergence and phylogenetic positions (Fig. 10) indicate a separate lineage in the upper portion of the Amazon River at localities in Colombia, from lineages in the upper and middle Amazon River basin of Brazil, Ecuador, and Peru.

It is worth noting that *Loricaria clavipinna* Fowler, 1940 is an additional species occurring in the upper Amazon basin, in the Ucayali River, Peru. Since that species occurs geographically near to the new species, a comparison with specimens of that species (see Material Examined in Londoño-Burbano *et al*., 2020) was carried out here. It was found that the new species can be differentiated from *L. clavipinna* by having dorsum of head and trunk, extending to three or four plates along the dorsal-fin base, dark brown, without spots or bands (*vs*. dorsum of head and trunk, light brown, with transversal bands starting at dorsal fin); dorsal and pectoral fins entirely black or dark brown, without spots or bands (*vs*. fins with disperse light brown or gray spots, not covering entire fins); caudal fin with dark pigment covering post-ural plates and distal tips of fin, interrupted by pale vertical band (*vs*. caudal fin with gray or brown longitudinal stripe covering lower lobe of fin); posterior lateral plates 13–16 (usually 14) *vs*. 15–17 (usually 16). Thus, we found evidence to correctly differentiate both populations on the upper Amazon River basin (Orteguaza and Putumayo rivers *vs*. Ucayali River) and to recognize the new lineage described herein. On the other hand, the nominal *Loricaria carinata* Castelnau, 1855, currently junior synonym of *L. cataphracta*, was described from the Amazon basin, Brazil. As was showed above, the new species is morphologically diagnosable from *L. cataphracta*, and molecular evidence places it in a different lineage, and not to the type species of the genus. This further supports presence of a new species in the upper Amazon River basin, Colombia.

The Andean region, including the portion influencing the upper Amazon River basin fish faunas, has undergone several geological rearrangements. According to Schaefer (2011), around the Late Paleocene, the Andean orogeny was initiated with major uplifts and alternating episodes of uplift and erosion which continued through the Cenozoic; some of the present elevation of central Andes was achieved by 20 million years ago (Mya), according to the author. Thus, much of the Andes in the central and northern regions is very young, and modern elevation was achieved no earlier than 2.7 Mya. The Andean influence in its central portion reaches localities on the upper Amazonas in Colombia, Ecuador, and Peru. A fish assemblage comprising the Amazon tributaries of Ecuador and southern Colombia, plus the Pacific drainages of Ecuador and Peru share approximately 50% faunal similarity (Schaefer, 2011); this agrees with what was found here regarding *Loricaria nimairaco* and *L. simillima*.

Loricaria nimairaco appears to have a discontinuous distribution in the piedmont (Orteguaza River) and the lowlands on the Amazon River basin (around Leticia, Colombia; Fig. 8), which is likely due to a lack of collecting effort in the middle portion of the Caquetá River in the upper Amazon River basin. Specimens from the Putumayo

River were recently collected by one of us (AUB), however, it is worth noting that the Putumayo River, mainly in localities within Colombia, is poorly surveyed and difficult to access, which is one of the main reasons for the lack of samples (for molecular analyses) in that basin. Moreover, having samples from both the piedmont and lowlands is an indication of the presence of the species not only along the intermediate portion of both points (Fig. 8), but maybe further along the Amazon River basin in the middle portion. Both the Caquetá and Putumayo rivers drain to the middle Amazon River when entering Brazil; however, samples from the middle Amazonas appear to be *L. simillima* based on morphological characters and the COI mitochondrial marker (see Diagnosis, Fig. 10, and Tab. 3). Due to the lack of samples from Brazilian localities, it is impossible to currently know the extent of the distribution of the new species and if it is present in the middle portion of the Amazonas River, or if it is endemic to Colombia, as it is assumed here.

Loricaria remains as a problematic group, but discovery and description of new species continues, even in poorly studied areas, such as the upper Amazon basin in Colombia as presented here. Although the genus is easily diagnosed, delimitation of most species of *Loricaria* remains unclear. A lack of understanding and identification of characters with taxonomic and phylogenetic signal could lead to inaccurate estimates of the number of valid species. Despite molecular phylogenies that have captured a large component of the diversity within the genus (*i.e.*, Covain *et al.*, 2016), a morphological characterization of species in a phylogenetic context has been needed for quite some time now. It is likely that new species of *Loricaria* will continue to be described; however, a phylogenetic study should be a priority for assessing the taxonomy of the genus.

Comparative material examined. See additional specimens examined in Londoño-Burbano *et al.* (2020). **Bolivia**: *Loricaria simillima*. BMNH 1988.2.1.51, 1, Santa Cruz, Amazon River basin, N. Dunstone. **Brazil:** *Loricaria* cf. *cataphracta*. MCP 51676, 8, Pará, Santarém, Amazonas River basin, Tapajós River, at Ponta do Jari, inside mouth of major whitewater channel discharging, 02°21'34.4"S 54°54'38.1"W; MCP 52212, 3, Pará, Santarém, Amazonas River basin, Amazonas River at the mouth of Lago do Tucumatuba, on the south margin of the main channel, 02°14'07.2"S 54°48'13"W; MCP 52238, 1, Pará, Óbidos, Amazonas River basin, on the south margin of the main channel of the river, approximately 60 km, 02°11'45.9"S 55°06'25.7"W; MNRJ 9402, 1, Pará, near Jacarecapá, Amazonas River basin, Lago Grande de Montealegre, *ca.* 02°14'S 54°17'W. *Loricaria* cf. *simillima*. MNRJ 723, 4, Amazonas, Manaus, Negro River basin, at city of Manaus, 03°06'07"S 60°01'30"W; MNRJ 1064, 12, Amazonas, Manaus, Negro River basin, at city of Manaus, 03°06'07"S 60°01'30"W; MNRJ 4424, 1, Amazonas, Borba, Amazonas River basin, Madeira River, at Borba Municipality; MNRJ 43628, 1, Amazonas, Manaus, Negro River basin. MNRJ 43629, 1, Amazonas, Manaus, Negro River basin. MNRJ 46872, 1, Amazonas, Manaus, Amazonas River basin, Negro River, Anavilhanas National Park, ICMBio basecamp, do Prato Lake, 02°43'10"S 60°45'18"W. *Loricaria simillima*. BMNH 1997.6.26.1-2, 2, Aquarium trade; MCP 46182, 2, Roraima, Caroebe, Negro River basin, Jauaperi River, at vicinal road, 5 or 10 km from BR-210, 00°54'47"N 59°34'23"W; MCP 46205, 1, Roraima, Rorainópolis, Negro River basin, Jaburu Stream, at vicinal road, BR-174 between Jundiá and Rorainópolis, 00°37'15"N 60°31'05"W; MNRJ 20963, 10, Amazonas, Amazonas River basin, near to Macapá, at little farm; MNRJ 20971, 2, Amazonas, Macapá, Amazonas River basin, Maruanum River, right tributary of Matapi River, at BR-156. *Loricaria* sp. MCP 36565, 5, Mato Grosso, Pontes e Lacerda,

Guaporé River basin, Bugre River, about 42 km north of Guaporé River, on BR-174, 14°51'35"S 59°17'57"W. **Ecuador:** *Loricaria simillima*. BMNH 1880.12.8.77, lectotype, Canelos, Buckley; BMNH 1880.12.8.78-80, 3 paralectotypes, same data as lectotype. **Peru:** *Loricaria* cf. *simillima*. MNRJ 3991, 1, Loreto, Amazonas River basin, Ampiyacu River, near Pebas along Amazonas River. **Suriname:** *Loricaria nickeriensis*. ZMA.PISC.107.561, holotype, Nickerie Fallawatra rivier, rapid in Fallawatra River, 5 km South West of Stondansie Fall, 05°5'59"N 56°31'00"W; ZMA. PISC.106.235, 3 paratypes, same data as holotype; ZMA.PISC.106.236, 8 paratypes, same data as holotype; ZMA.PISC.106.237, 8 paratypes, same data as holotype; ZMA.PISC.116.680, 8, Guyana, Georgetown, Essequibo River.

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REFERENCES

- **Ayram CAC, Etter A, Díaz-Timoté J, Buriticá SR, Ramírez W, Corzo G.** Spatiotemporal evaluation of the human footprint in Colombia: Four decades of anthropic impact in highly biodiverse ecosystems. Ecol Indic. 2020; 117:106630. https://doi.org/10.1016/j.ecolind.2020.106630
- **Bachman S, Moat J, Hill AW, de la Torre J, Scott B.** Supporting red list threat assessments with GeoCAT: Geospatial conservation assessment tool. ZooKeys. 2011; (150):117–26. https://doi.org/10.3897/zookeys.150.2109

- **Bouckaert R, Vaughan TG, Barido-Sottani J, Duchêne S, Fourment M, Gavryushkina A *et al*.** BEAST 2.5: An advanced software platform for Bayesian evolutionary analysis. PLoS Comput Biol. 2019; 15(4):e1006650. https://doi.org/10.1371/journal.pcbi.1006650
- **Clerici N, Armenteras D, Kareiva P, Botero R, Ramírez-Delgado JP, Forero-Medina G *et al*.** Deforestation in Colombian protected areas increased during post-conflict periods. Sci Rep. 2020; 10(4971). https://doi.org/10.1038/s41598-020-61861-y
- **Covain R, Fisch-Muller S, Oliveira C, Mol JH, Montoya-Burgos JI, Dray S.** Molecular phylogeny of the highly diversified catfish subfamily Loricariinae (Siluriformes, Loricariidae) reveals incongruences with morphological classification. Mol Phylogenet Evol. 2016; 94:492–517. https://doi.org/10.1016/j.ympev.2015.10.018
- **Drummond AJ, Rambaut A.** BEAST: Bayesian evolutionary analysis by sampling trees. BMC Evol Biol. 2007; 7:214. https://doi.org/10.1186/1471-2148-7-214
- **Ferraris Jr. CJ.** Checklist of catfishes, recent and fossil (Osteichthyes: Siluriformes), and catalogue of siluriform primary types. Zootaxa. 2007; 1418(1):1–628. https://doi.org/10.11646/zootaxa.1418.1.1
- **Fricke R, Eschmeyer WN, Van der Laan R.** Eschmeyer's catalog of fishes: genera, species, references [Internet]. San Francisco: California Academy of Science; 2023. Available from: http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp
- **Galvis G, Mojica JI, Duque SR, Castellanos C, Sánchez-Duarte P, Arce M *et al*.** Peces del medio Amazonas. Región de Leticia. Serie de Guías Tropicales de Campo Nº 5. Conservación Internacional. Editorial Panamericana, Formas e Impresos. Bogotá, Colombia; 2006.
- **Isbrücker IJH.** Description préliminaire de nouveaux taxa de la famille des Loricariidae, poissons-chats cuirassés néotropicaux, avec un catalogue critique de la sousfamille nominale (Pisces, Siluriformes). RFAH. 1979; 5(4):86–116.
- **Isbrücker IJH.** Classification and catalogue of the mailed Loricariidae (Pisces, Siluriformes). Verslag Techn Gegevens Inst Taxon Zöol. 1980; 22:1–181.
- **Isbrücker IJH.** Revision of *Loricaria* Linnaeus, 1758 (Pisces, Siluriformes, Loricariidae). Beaufortia. 1981; 31(3):51–96.
- **International Union for Conservation of Nature (IUCN). Standards and petitions committee.** Guidelines for using the IUCN Red List categories and criteria. Version 15 [Internet]. Gland; 2022. Available from: http://www.iucnredlist.org/documents/RedListGuidelines.pdf
- **Kimura M.** A simple method for estimating evolutionary rate of base substitutions through comparative studies of nucleotide sequences. J Mol Evol. 1980; 16(2):111–20. https://doi.org/10.1007/bf01731581
- **Lanfear R, Calcott B, Ho SYW, Guindon S.** PartitionFinder: combined selection of partitioning schemes and substitution models for phylogenetic analyses. Mol Biol Evol. 2012; 29(6):1695–701. https://doi.org/10.1093/molbev/mss020
- **Linnaeus C.** Systema Naturae, Ed. X. (Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Tomus I. Editio decima, reformata.). Holmiae. 1758; 1:1–824.
- **Londoño-Burbano A, Britto MR.** A new species of *Sturisoma* Swainson, 1838 (Loricariidae: Loricariinae) from the Madeira River basin, with a discussion of historical biogeography of western Amazonas and Paraguay River basins. J Fish Biol. 2022; 102(1):188–203. https://doi.org/10.1111/jfb.15251
- **Londoño-Burbano A, Reis RE.** A taxonomic revision of *Sturisomatichthys* Isbrücker and Nijssen, 1979 (Loricariidae: Loricariinae), with descriptions of three new species. Copeia. 2019; 107(4):764–806. https://www.jstor.org/stable/26900511

- **Londoño-Burbano A, Reis RE.** A combined molecular and morphological phylogeny of the Loricariinae (Siluriformes: Loricariidae), with emphasis on the Harttiini and Farlowellini. PLoS ONE. 2021; 16(3):e0247747. https://doi.org/10.1371/journal.pone.0247747
- **Londoño-Burbano A, Urbano-Bonilla A, Thomas MR.** *Loricaria cuffyi* (Siluriformes: Loricariidae), a new species of loricariin catfish from the Guiana Shield. J Fish Biol. 2020; 98(1):154–67. https://doi.org/10.1111/jfb.14566
- **Minor EE, Hendrich-Minor D.** Vocabulario Huitoto-Muinane. Serie lingüística peruana publicación N° 5. 2008.
- **Müller S, Weber C.** Les dents des sous-familles Hypostominae et Ancistrinae (Pisces, Siluriformes, Loricariidae) et leur valeur taxonomique. Rev Suisse Zool. 1992; 99:747–54.
- **Papa Y, Le Bail P-Y, Covain R.** Genetic landscape clustering of a large DNA barcoding data set reveals shared patterns of genetic divergence among freshwater fishes of the Maroni Basin. Mol Ecol Resour. 2021; 21(6):2109–24. https://doi.org/10.1111/1755-0998.13402
- **Pattengale ND, Alipour M, Bininda-Emonds ORP, Moret BME, Stamatakis A.** How many bootstrap replicates are necessary? In: Batzoglou S, editor. Research in Computational Molecular Biology. Lect Notes Comput Sci. 2009; 5541:184–200. https://doi.org/10.1007/978-3-642-02008-7_13
- **Pereira LHG, Hanner R, Foresti F, Oliveira C.** Can DNA barcoding accurately discriminate megadiverse Neotropical freshwater fish fauna? BMC Genet. 2013; 14(20):1–14. https://doi.org/10.1186/1471-2156-14-20
- **Puillandre N, Lambert A, Brouillet S, Achaz G.** ABGD, Automatic Barcode Gap Discovery for primary species delimitation. Mol Ecol. 2012; 21(8):1864–77. https://doi.org/10.1111/j.1365-294X.2011.05239.x
- **R Development Core Team.** R: A language and environment for statistical computing, version 4.2.2. Vienna, Austria: R Foundation for Statistical Computing; 2021. Available from: https://www.r-project.org/
- **Rambaut A.** FigTree v. 1.4.4., a graphical viewer of phylogenetic trees. [Internet]. University of Edinburgh: Institute of Evolutionary Biology; 2018. http://tree.bio.ed.ac.uk/software/figtree/
- **Rambaut A, Drummond AJ, Xie D, Baele G, Suchard MA.** Posterior summarization in Bayesian phylogenetics using tracer 1.7. Syst Biol. 2018; 67(5):901–04. https://doi.org/10.1093/sysbio/syy032
- **Rapp Py-Daniel LH.** Phylogeny of the Neotropical armored catfishes of the subfamily Loricariinae (Siluriformes: Loricariidae). [PhD Thesis]. Tucson: University of Arizona; 1997.
- **Rapp Py-Daniel LH, Cox Fernandes C.** Sexual dimorfism in Amazonian Siluriformes and Gymnotiformes (Ostariophysi). Acta Amazon. 2005; 35(1):97–110. https://doi.org/10.1590/S0044-59672005000100015
- **Regan CT.** A monograph of the fishes of the family Loricariidae. Trans Zool Soc London. 1904; 17:191–350.
- **Sabaj MH.** Codes for natural history collections in ichthyology and herpetology. Copeia. 2020; 108(3):593–669. https://doi.org/10.1643/ASIHCODONS2020
- **Saraiva ACS, Abreu JMS, Ottoni FP, Piorski NM.** A new species of *Loricaria* (Siluriformes: Loricariidae) from the Turiaçu River basin, Eastern Amazon region, Brazil. Zootaxa. 2021; 4915(3):424–34. https://doi.org/10.11646/zootaxa.4915.3.10
- **Schaefer SA.** The Andes riding the tectonic uplift. In: Albert JS, Reis RE, editors. Historical biogeography of neotropical freshwater fishes. Univ. California Press; 2011. p.259–78. https://doi.org/10.1525/california/9780520268685.003.0016
- **Stamatakis A.** RAxML version 8: a tool for phylogenetic analysis and postanalysis of large phylogenies. Bioinformatics. 2014; 30(9):1312–13. https://doi.org/10.1093/bioinformatics/btu033
- **Tamura K, Stecher G, Kumar S.** MEGA11: Molecular evolutionary genetics analysis version 11. Mol Biol Evol. 2021; 38(7):3022–27. https://doi.org/10.1093/molbev/msab120

- **Thomas MR.** Systematic revision of the South American armored catfish genus *Loricaria* Linnaeus (Siluriformes: Loricariidae). [PhD Thesis]. Carbondale: Southern Illinois University; 2011.
- **Thomas MR, Rapp Py-Daniel LH.** Three new species of the armored catfish genus *Loricaria* (Siluriformes: Loricariidae) from river channels of the Amazon basin. Neotrop Ichthyol. 2008; 6(3):379–94. https://doi.org/10.1590/S1679-62252008000300011
- **Thomas MR, Rodriguez MS, Cavallaro MR, Froehlich G, Castro RMC.** *Loricaria luciae*, a new species of whiptail catfish (Siluriformes: Loricariidae) from the Paraguay and lower Paraná River basins of southeastern South America. Zootaxa. 2013; 3745(3):365–78. https://doi.org/10.11646/zootaxa.3745.3.4
- **Thomas MR, Sabaj Pérez MH.** A new species of whiptail catfish, genus *Loricaria* (Siluriformes: Loricariidae), from the rio Curuá (Xingu basin), Brazil. Copeia. 2010; 2010(2):274–83. http://dx.doi.org/10.2307/40863447

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Alejandro Londoño-Burbano: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing-original draft, Writing-review and editing.

Alexander Urbano-Bonilla: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Software, Validation, Visualization, Writing-review and editing.

Matthew R. Thomas: Data curation, Formal analysis, Methodology, Validation, Visualization, Writing-review and editing.

Marcelo R. Britto: Funding acquisition, Resources, Software, Validation, Writing-review and editing.

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