



A new short-snouted species of *Farlowella* (Siluriformes: Loricariidae) from the upper Paraguai River basin

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A new species of *Farlowella* is described from the upper Paraguai River basin, Mato Grosso State, Brazil. The species was investigated by morphological and molecular datasets. The new species can be distinguished from its congeners by the following character combination: (1) absence of gular plates, (2) absence of breeding odontodes, (3) absence of the mid-dorsal plate series, (4) complete series of central abdominal plates, (5) five total rays in the pelvic fin, (6) modally i,10,i rays in the caudal fin, (7) lateral contour of the snout distinctly concave in dorsal view and (8) dorsal caudal-fin lobe fully covered with melanophores and ventral lobe pigmented only ventrally in adults. The new species has the smallest body size recorded for any species of *Farlowella*, not exceeding 96 mm in standard length (SL). Genetic divergence between the new species and other *Farlowella* ranged from 3.1–12.5% and three delimitation analyses recovered it as an independent lineage. A review of the cytochrome c oxidase subunit I (COI) sequences for *Farlowella* deposited in public repositories, an additional record of sexual dimorphism in the cloaca and a discussion about other species from the Paraguai River basin are provided.

Keywords: Biodiversity, DNA barcode, Genetic distances, Stick catfishes, Taxonomy.

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Uma nova espécie de *Farlowella* é descrita da bacia do alto rio Paraguai, Estado do Mato Grosso, Brasil. A espécie foi investigada por dados morfológicos e moleculares. A nova espécie pode ser distinguida de suas congêneres pela seguinte combinação de caracteres: (1) ausência de placas gulares, (2) ausência de odontódeos reprodutivos, (3) ausência de placas da série médio-dorsal, (4) série completa de placas abdominais centrais, (5) cinco raios totais na nadadeira pélvica, (6) modalmente i,10,i raios na nadadeira caudal, (7) contorno lateral do focinho distintamente côncavo em vista dorsal e (8) lobo dorsal totalmente coberto de melanóforos e lobo ventral com apenas a porção ventral da nadadeira caudal pigmentada em adultos. A nova espécie apresenta o menor tamanho corporal registrado para uma *Farlowella*, não excedendo 96 mm de comprimento padrão (SL). A distância genética entre a nova espécie e outras *Farlowella* variou de 3,1%–12,5% e três análises de delimitação a recuperaram como uma linhagem independente. É apresentada uma revisão das sequências de subunidade I do citocromo c oxidase (COI) de *Farlowella* depositadas em repositórios públicos, um registro adicional de dimorfismo sexual na cloaca e uma discussão sobre outras espécies da bacia do rio Paraguai.

Palavras-chave: Biodiversidade, Cascudo-graveto, Código de barra de DNA, Distância genética, Taxonomia.

INTRODUCTION

Farlowella Eigenmann & Eigenmann, 1889 is the second richest genus in Loricariinae, with 32 valid species (Dopazo *et al.*, 2023; Fricke *et al.*, 2025). Its representatives are widely distributed in the main cis-Andean drainages of South America (Amazon, Orinoco and Paraná), trans-Andean basins of the Maracaibo and Magdalena Rivers, and coastal drainages of the Guiana and Venezuela shields (Ballen, Mojica, 2014; Terán *et al.*, 2019). These fish are easily recognized by their pronounced snout; slender, elongated body; and brown (or tan) ground color of body with two longitudinal stripes extending from the tip of the snout to the caudal peduncle (Covain, Fisch-Muller, 2007), resembling dry branches or twigs. Furthermore, *Farlowella* (including *Aposturisoma* Isbrücker, Britski, Nijssen & Ortega, 1983) is distinguished from all other Loricariidae, except the Hypoptopomatinae *Acestridium* Haseman, 1911, by having the origin of the dorsal and the anal fins approximately aligned *vs.* anal-fin origin distinctly posterior to a vertical through dorsal-fin origin in all other Loricariidae (Isbrücker, 1979:90; Retzer, Page, 1996:40; Reis, 2018; Armbruster *et al.*, 2018; Covain, Van der Sleen, 2018). Although superficially similar to *Farlowella*, species of *Acestridium* differ from that genus by several characteristics, one of the most conspicuous being the presence, in *Acestridium*, of one or two zygous plates immediately anterior to the nuchal plate (Reis, Lehmann, 2009) *vs.* no zygous plates anterior to the dorsal fin in *Farlowella*.

The species of *Farlowella* have all been described based on morphological and anatomical characters, including the species described in the last taxonomic revision of *Farlowella* by Retzer, Page (1996), viz. *F. colombiensis*, *F. isbruckeri*, *F. odontotumulus*,

F. paraguayensis, *F. platorynchus* [= *F. amazonum* (Günther, 1864)], and *F. taphorni*; and species described after Retzer, Page (1996), viz. *F. altocorpus* Retzer, 2006, *F. yarigui* Ballen & Mojica, 2014, *F. gianetii* Ballen, Pastana & Peixoto, 2016, *F. mitoupibo* Ballen, Urbano-Bonilla & Zamudio, 2016, *F. azpelicuetae* Terán, Ballen, Alonso, Aguilera & Mirande, 2019, and *F. wuyjugu* Dopazo, Wosiacki & Britto, 2023. However, the use of molecular tools to identify additional fish diversity in the Neotropical region has become a regular practice, especially in Loricariinae species (e.g., Costa-Silva *et al.*, 2015; Londoño-Burbano, Britto, 2023; Mejia *et al.*, 2023).

Based on the extensive examination of *Farlowella* material in collections as part of a revision of the genus prepared by the first author during her doctoral dissertation, including the assessment of morphological aspects and molecular characters, a new species from the Paraguai River basin was detected. This is the first species of *Farlowella* described including a molecular data set. A review of the cytochrome c oxidase subunit I (COI) sequences for *Farlowella* deposited in public repositories, an additional record of sexual dimorphism in the cloaca, and a discussion about other species from the Paraguai River basin are provided.

MATERIAL AND METHODS

Morphological analysis. Measurements were taken point to point with digital calipers. Measurements are expressed as percents of the standard length, except subunits of head, which are expressed as percents of the head length. Measurements follow Dopazo *et al.* (2023), which followed previous studies summarized in Tab.1. Counts and terminology of lateral plate series follow Schaefer (1997). Osteological terminology follows Paixão, Toledo-Piza (2009), except for parieto-supraoccipital instead of supraoccipital (Arratia, Gayet, 1995). Numbers in parentheses following meristic counts correspond to number of specimens having that count, and those indicated by an asterisk belong to the holotype. The sample size of all morphometric and meristic data was 27, except when measurements and counts were impossible due to damaged structures. However, for important diagnostic characters, the largest number of specimens available was analyzed, such as the characters of the abdominal plates, and the number of pelvic- and caudal-fin rays.

The terms allometry and allochromy are used in the same sense as in Deprá *et al.* (2021). The diagnosis included only the species of *Farlowella* considered valid by Fricke *et al.* (2025), i.e., the name proposed by Delgadillo *et al.* (2021) is not available because the article does not comply with Art. 8 of the International Code of Zoological Nomenclature due to the lack of a ZooBank registration (Anonymous, 1999). Comparative data for *Farlowella martini* Fernández-Yépez, 1972, *F. odontotumulus* and *F. taphorni* were obtained from their original descriptions. Several specimens were dissected to confirm the sex. A regression analysis and scatter plot were carried out using Microsoft Excel. Abbreviations: CS = cleared and counterstained, HL = head length, and SL = standard length. Institutional codes follow Sabaj (2020, 2025).

TABLE 1 | List of measurements and their explanations, with reference to previous studies.

Measures	Description of measurements and references
Standard length	From the tip of the snout to the posterior margin of the last plate located on the caudal peduncle (Boeseman, 1971; Isbrücker, Nijssen, 1978)
Head length	From the tip of the snout to the distal margin of the parieto- supraoccipital process (Boeseman, 1971; Isbrücker, Nijssen, 1978)
Body depth at dorsal-fin origin	From the point immediately anterior to the dorsal-fin spine to the ventral midline of the body, along a vertical line (Boeseman, 1971; Isbrücker, Nijssen, 1978)
Body width at dorsal-fin origin	Width of the body immediately anterior to the dorsal fin (Isbrücker, Nijssen, 1978)
Body width at anal-fin origin	Width of the body immediately anterior to the anal fin (Boeseman, 1971; Isbrücker, Nijssen, 1978)
Predorsal length	From the tip of the snout to the posterior margin of the nuchal plate (Boeseman, 1971; “predorsal shield” in Isbrücker, Nijssen, 1978)
Post-dorsal length	From the base of the last dorsal-fin ray to the posterior margin of the last plate located on the caudal peduncle (Boeseman, 1971; Isbrücker, Nijssen, 1978)
Postanal length	From the base of the last anal-fin ray to the posterior margin of the last plate located on the caudal peduncle (Boeseman, 1971; Isbrücker, Nijssen, 1978)
Prepelvic length	From the tip of the snout to the base of the pelvic-fin spine (Vera-Alcaraz <i>et al.</i> , 2012)
Distance from parieto-supraoccipital to dorsal fin	Between the distal margin of the parieto-supraoccipital process and the base of the dorsal-fin spine (Boeseman, 1971)
Caudal peduncle depth	Minimum depth of the caudal peduncle (Boeseman, 1971)
Dorsal-fin length	Total length of the first dorsal-fin ray, measured from the base to its tip (Boeseman, 1971; Isbrücker, Nijssen, 1978)
Pectoral-fin length	Total length of the first pectoral-fin ray, measured from the base to its tip (Boeseman, 1971; Isbrücker, Nijssen, 1978)
Pelvic-fin length	Total length of the first pelvic-fin ray, measured from the base to its tip (Boeseman, 1971; Isbrücker, Nijssen, 1978)
Anal-fin length	Total length of the first anal-fin ray, measured from the base to its tip (Boeseman, 1971; Isbrücker, Nijssen, 1978)
Pectoral-fin origin to pelvic-fin origin	From the anterior face of the pectoral-fin spine base to the pelvic-fin spine base “thoracic length” in Isbrücker, Nijssen, 1978
Pelvic-fin origin to anal-fin origin	From the anterior face of the pelvic-fin spine base to the anal-fin spine base abdominal length in Isbrücker, Nijssen, 1978
Distance between cleithral processes	Distance between tips of contralateral cleithral processes approximately equivalent to cleithral width of Isbrücker, Nijssen, 1978
Head width	Maximum width of head, from opercle to contralateral opercle (Boeseman, 1971)
Head depth	From the posterior margin of the parieto-supraoccipital process to the ventral midline of the body, along a vertical line (Boeseman, 1971; Isbrücker, Nijssen, 1978)
Snout-mouth length	From the tip of the snout to the anteriormost point in the pre-oral arch (<i>i.e.</i> , the arch formed by the posterior margins of the plates that surround the mouth anteriorly; Retzer, Page, 1996; equivalent to “length of lower armored snout” of Boeseman, 1971)
Minimum width of snout	Measured at the point where the snout begins to taper abruptly towards its tip (see Dopazo <i>et al.</i> , 2023, fig. 1A)
Maximum width of snout	Measured at the base of the rostrum, where it is crossed by a transversal line through to the anteriormost point in the pre-oral arch (see Dopazo <i>et al.</i> , 2023, fig. 1C)
Snout length	From the tip of the snout to the anteriormost point of the orbital margin (Isbrücker, Nijssen, 1978)
Eye diameter	Horizontal length of the orbit (Boeseman, 1971)
Interorbital width	Minimum distance between the orbital margins (Boeseman, 1971)
Postorbital head length	From posterior margin of parieto-supraoccipital process (at midline of body) to closest point on posterior margin of orbit (Boeseman, 1971)
Internarial distance	Minimum bony distance between the left and right nostrils (Vera-Alcaraz <i>et al.</i> , 2012)

Molecular data and analyses. Our molecular data set encompassed 39 sequences of the mitochondrial gene cytochrome c oxidase subunit I (COI), including one sequence of the outgroup taxon *Sturisomatichthys citurensis* (Meek & Hildebrand, 1913) (GenBank accession number MG937278). The 27 sequences of *Farlowella* species used in the present work were those already available on GenBank and BOLD; as well as 11 newly generated sequences, including the new species described herein (Tab. 2). Vouchers (specimens or photographs) for available sequences in Genbank and BOLD were examined whenever possible to avoid misinterpretation during the molecular species delimitation. Muscular tissue from selected specimens was digested for DNA extraction using the salting out method proposed by Miller *et al.* (1988) or using Quick-DNA-Miniprep-Zymo Research kit following the manufacturer's protocol. DNA quality was verified with standard agarose gel electrophoresis and DNA concentration was measured using a NanoDrop ND-2000 spectrophotometer. Partial sequences of COI were amplified via the Polymerase Chain Reaction (PCR) using FishF1 (5'-TCAACCAACCACAAAGACATTGGCAC-3') and FishR1 (5'-TAGACTTCTGGGTGGCCAAAGAATCA-3') primers developed by Ward *et al.* (2005). The solution for PCR cycles had a total volume of 25 µl: 1 µl of DNA template, 12.5 µl of PCR Master Mix (Invitrogen), 10 µl of nuclease-free water and 0.75 µl of each primer (forward and reverse). The PCR protocol for both primers was as follows: denaturation at 94°C/30s, 35 cycles of 94°C/45s, 50°C/30s and 72°C/45s, and a final extension step of 72°C/10 min. Amplified products were checked using 2% agarose gel electrophoresis. PCR products were purified using ExoSAP-ITPCR Product Cleanup Reagent (Applied Biosystems) (Handy *et al.*, 2011) or PEG (Lis, 1980; Jennings, 2017). PCR products were sequenced in both directions on an ABI3730xl (Applied Biosystems) automated sequencer at the Fundação Oswaldo Cruz (FIOCRUZ). The resulting sequences were aligned to a reference sequence using the Geneious software (Kearse *et al.*, 2012) and then manually edited to fine tune base calls and ensure codon alignment.

The final alignment of all sequences was performed in the MEGAX program (Kumar *et al.*, 2016) using the MUSCLE algorithm, resulting in a single alignment of 611bp. Evolutionary distances between COI gene sequences were estimated using the distance Kimura-2 parameters (K2P) paired in the MEGAX program and distances compared between species and between representatives of the same species. For estimated pairwise genetic distances, molecular operational taxonomic units (MOTUs) were selected based on the automatic species delimitation results. For automatic species delimitation, we used three approaches: the automatic barcode gap discovery (ABGD; Puillandre *et al.*, 2012), the generalized mixed Yule coalescent method (GMYC; Fujisawa, Barraclough, 2013; Pons *et al.*, 2006) and the Poisson tree process model (PTP; Zhang *et al.*, 2013). ABGD was implemented with a matrix of aligned nucleotide sequences (generated in MEGAX) as input file in the ABGD web server (<https://bioinfo.mnhn.fr/abi/public/abgd/abgdweb.html>) under Kimura (k80) model = 2.0, X (relative gap width) = 1.2 and Pmin = 0.001, Pmax = 0.1; Steps 10; Nb bins = 10. For the GMYC analysis, an ultrametric tree was estimated in BEAST v. 1.8 (Drummond *et al.*, 2015) with four independent MCMC runs of 10 million generations and uncorrelated lognormal relaxed clock model, HKY model as best model selected in jModelTest (Posada, 2008). Parameter distributions (ESS values ≥ 200) were examined in Tracer v. 1.7 (Rambaut *et al.*, 2018).

TABLE 2 | COI mitochondrial gene sequence samples used in the present study. Marked (*) accession numbers generated in this study.

Original identification	Reviewed identification	Voucher	Tissue	GenBank or BOLD accession number (COI)
<i>Farlowella</i> sp.	<i>Farlowella acus</i>	ICT-FCA-55	TICT-FCA-78	FBCH068-21
<i>Farlowella</i> sp.	<i>Farlowella acus</i>	ICT-FCA-56	TICT-FCA-163	FBCH110-21
<i>Farlowella</i> sp.	<i>Farlowella acus</i>	ICT-FCA-32	TICT-FCA-188	FBCH130-21
<i>Farlowella vittata</i>	<i>Farlowella acus</i>	ICT-FCA-48	TICT-FCA-147	FBCH140-21
<i>Farlowella vittata</i>	<i>Farlowella acus</i>	LENG04	TICT-FCA-267	FBCH155-21
<i>Farlowella</i> sp.	<i>Farlowella acus</i>	ICT-FCA-44	TICT-FCA-17	FBCH173-21
<i>Farlowella rugosa</i>	<i>Farlowella amazonum</i>	-	853 IIAP	KT952443/ GBMIN119706-17
<i>Farlowella henriquei</i>	<i>Farlowella amazonum</i>	-	903 IIAP	GBMIN124595-17
<i>Farlowella curtirostra</i>	<i>Farlowella curtirostra</i>	CIUA 8320	CIUA 8320A	AA4376
<i>Farlowella amazonum</i>	<i>Farlowella hahni</i>	LBP 44975	LBPV-44975	JN988860/ FUPR1345-10
<i>Farlowella amazonum</i>	<i>Farlowella hahni</i>	LBP 44976	LBPV-44976	JN988859/ FUPR1346-10
<i>Farlowella amazonum</i>	<i>Farlowella hahni</i>	LBP 26397	LBPV-26397	GU701788/ FUPR500-09
<i>Farlowella amazonum</i>	<i>Farlowella hahni</i>	LBP 26398	LBPV-26398	GU701787/ FUPR501-09
<i>Farlowella amazonum</i>	<i>Farlowella hahni</i>	LBP 26399	LBPV-26399	GU701790/ FUPR502-09
<i>Farlowella amazonum</i>	<i>Farlowella hahni</i>	LBP 26400	LBPV-26400	GU701789/ FUPR503-09
<i>Farlowella amazonum</i>	<i>Farlowella hahni</i>	LBP 26401	LBPV-26401	GU701894/ FUPR504-09
<i>Farlowella</i> sp.	<i>Farlowella hahni</i>	UNMDP-T 2843	UNMDP-T 2843	FWFA351-15
<i>Farlowella</i> sp.	<i>Farlowella hahni</i>	UNMDP-T 2844	UNMDP-T 2845	FWFA352-15
<i>Farlowella nattereri</i>	<i>Farlowella hasemani</i>	-	ANSP 182779	HM049036/ GBGCA122-10
<i>Farlowella nattereri</i>	<i>Farlowella hasemani</i>	INPA 43891	UFAM CTGA 14331	KP772581/ GBGCA12896-15
<i>Farlowella isbruckeri</i>	<i>Farlowella isbruckeri</i>	UFRO-ICT 22871	T11486	PV771493*
<i>Farlowella</i> sp.	<i>Farlowella knerii</i>	-	855 IIAP	KT952442
<i>Farlowella smithi</i>	<i>Farlowella knerii</i>	-	849 IIAP	KT952444/ GBMIN95064-17
<i>Farlowella</i> sp.	<i>Farlowella knerii</i>	-	-	MG777576
<i>Farlowella</i> sp.	<i>Farlowella nattereri</i>	-	847 IIAP	KT952439
<i>Farlowella nattereri</i>	<i>Farlowella nattereri</i>	-	852 IIAP	KT952441/GBMIN129831-17
<i>Farlowella paraguayensis</i>	<i>Farlowella paraguayensis</i>	LBP 8497	LBP 41736	PV771496*
<i>Farlowella paraguayensis</i>	<i>Farlowella paraguayensis</i>	LBP 8497	LBP 41737	PV771494*
<i>Farlowella paraguayensis</i>	<i>Farlowella paraguayensis</i>	LBP 10769	LBP 49836	PV771495*
<i>Farlowella paraguayensis</i>	<i>Farlowella paraguayensis</i>	STRI-01787	STRI-2205	PV771497*
<i>Farlowella paraguayensis</i>	<i>Farlowella paraguayensis</i>	STRI-01787	STRI-2206	PV771498*
<i>Farlowella reticulata</i>	<i>Farlowella reticulata</i>	MHNG 2683.081	GF06-637	MZ051934/GBOL257-13
<i>Farlowella reticulata</i>	<i>Farlowella reticulata</i>	MHNG 2743.062	SU08-1281	MZ051215/GBOL967-16
<i>Farlowella wuyjugu</i>	<i>Farlowella wuyjugu</i>	MPEG uncat.	MPEGJUR03	PV771500*
<i>Farlowella wuyjugu</i>	<i>Farlowella wuyjugu</i>	MPEG uncat.	MPEGJUR04	PV771499*
<i>Farlowella kirane</i>	<i>Farlowella kirane</i>	LBP 8556	LBP 43311	PV771490*
<i>Farlowella kirane</i>	<i>Farlowella kirane</i>	LBP 8556	LBP 43312	PV771491*
<i>Farlowella kirane</i>	<i>Farlowella kirane</i>	LBP 8413	LBP 41541	PV771492*

The four runs were combined with LogCombiner v. 1.8.4 (Rambaut, Drummond, 2016a) and then summarized in TreeAnnotator v. 1.8.4 (Rambaut, Drummond, 2016b) with 25% of the trees discarded as burn-in. GMYC was implemented with a tree (generated in BEAST) as input file in the GMYC web (<https://species.h-its.org/gmyc/>) using the single threshold parameter and keeping other parameters at default values. For the PTP delimitation method, a metric tree was generated on the IqTree web server (<http://www.iqtree.org/>) using Maximum Likelihood following the default parameters with HKY model and Standard Bootstrap analysis (1000 replicates). The best tree produced was then the input file on the PTP web server (<https://species.h-its.org/ptp/>), which also followed the default values of 100.000 generations and thinning=100.

RESULTS

Farlowella kirane, new species

urn:lsid:zoobank.org:act:93F9E38A-FA61-4031-A44B-683A26748E5A

(Figs. 1–2; Tab. 3)

Holotype. MNRJ 55993, 95.9 mm SL, Brazil, State of Mato Grosso, between Nova Marilândia and Santo Afonso, Córrego das Pedras, tributary to Córrego Vermelho, Sepotuba River basin, Paraguai River basin, 14° 21'03"S 57° 33'07"W, C. H. Zawadzki, 14 Sep 2010.



FIGURE 1 | Ventral, lateral and dorsal views of *Farlowella kirane*, holotype, MNRJ 55993, 95.9 mm SL.

Paratypes. All from Brazil, Mato Grosso, Sepotuba River basin, Paraguai River basin. LBP 8399, 14, 41.5–90.2 mm SL, type-locality, 17 Jul 2009, R. Devidé, J. C. P. Alves, V. P. Cruz, G. J. C. Silva & W. Troy. LBP 8413, 3, 87.1–88.4 mm SL, Santo Afonso, Mato Grosso, Tangará da Serra, stream with unknown name, 14°27'26.3"S 57°34'34.0"W, same collectors and date as LBP 8399. LBP 8556, 14, 63.9–94.5 mm SL, Mato Grosso, between Nova Marilândia and Santo Afonso, Tangará da Serra, Córrego Vermelho, 14°20'32.6"S 57°31'22.5"W, same collectors as LBP 8399, 23 Jun 2009. LBP 11932, 9, 60.1–88.6 mm SL, type-locality, W. Troy, 16 Feb 2009. LBP 33961, 122 (18 young; 55 males; 49 females), 21.3–91.9 mm SL, Nova Marilândia, rio Maracanã. NUP 10968, 35, 25.5–91.8 mm SL, same data as holotype.

Diagnosis. *Farlowella kirane* is diagnosed from all congeners, except *F. wuyjugu*, by having the gular region naked, that is, devoid of gular plates *vs.* plates present (Fig. 3). *Farlowella kirane* is distinguished from *F. wuyjugu* by having from four to five



FIGURE 2 | *Farlowella kirane*, NUP 10968, not measured, in life collected in Córrego das Pedras, tributary to Córrego Vermelho, Sepotuba River basin, upper Paraguai River basin, between Nova Marilândia and Santo Afonso, State of Mato Grosso, 14°21'03"S 57°33'07"W.

TABLE 3 | Morphometric data of *Farlowella kirane*. Values as percents of standard length (SL) and head length (HL) for holotype and paratypes. N = Number of specimens, SD = Standard deviation.

	N	Holotype	Range	Mean	SD
Standard length (mm)	27	95.9	69.9–95.9	83.4	–
Percents of standard length					
Head length	27	23.5	22.6–28.0	24.7	1.4
Body depth at dorsal-fin origin	26	4.9	4.7–6.5	5.4	0.4
Body width at dorsal-fin origin	23	5.5	5.5–6.8	6.1	0.4
Body width at anal-fin origin	24	5.5	5.5–6.8	6.1	0.4
Predorsal length	27	45.0	42.0–48.0	44.5	1.5
Postdorsal length	27	50.2	48.2–55.5	51.2	1.7
Postanal length	27	51.6	48.0–56.2	51.4	1.9
Prepelvic length	27	32.3	30.1–36.1	32.3	1.5
Distance from parieto-supraoccipital to dorsal fin	27	22.0	18.5–22.0	20.1	0.9
Caudal peduncle depth	27	0.9	0.7–1.2	1.0	0.1
Dorsal-fin length	26	14.1	13.7–17.1	15.1	0.9
Pectoral-fin length	26	10.9	9.9–12.8	11.2	0.8
Pelvic-fin length	27	7.9	6.9–9.1	8.1	0.6
Anal fin-length	27	13.0	11.9–15.4	13.7	1.0
Distance from pectoral-fin origin to pelvic-fin origin	27	11.8	8.8–12.6	10.9	0.8
Distance between cleithral processes	18	6.9	6.6–8.5	7.6	0.5
Percents of head length					
Head width	27	30.9	28.0–35.3	31.9	1.9
Head depth	27	21.4	21.0–27.4	23.5	1.7
Snout-mouth length	27	28.2	26.2–36.2	30.9	2.3
Minimum width of snout	27	4.7	3.8–6.4	5.0	0.7
Maximum width of snout	27	12.0	10.5–16.7	13.2	1.5
Snout length	27	70.4	70.0–76.0	73.6	1.4
Eye diameter	27	8.2	6.3–9.4	7.6	0.8
Interorbital width	27	20.3	17.6–23.3	20.5	1.5
Postorbital head length	27	25.6	21.6–26.0	23.7	1.3
Distance between nostrils	27	8.5	6.8–10.4	8.5	0.9

total pelvic-fin rays *vs.* six total rays; by having i,10,i, rarely i,9,i (see description for more details) rays in the caudal fin *vs.* i,12,i (rarely i,11,i); lateral contour of the snout distinctly concave in dorsal view *vs.* nearly straight (compare Fig. 1 with figs. 2–3 in Dopazo *et al.*, 2023); caudal-fin filaments, when present, shorter than half the total length of the branched rays *vs.* longer than half the total length of the branched rays; and midabdominal plate series complete and continuous or nearly continuous in 95.6% of the specimens *vs.* incomplete in more than half of the specimens (Fig. 4). *Farlowella kirane* is diagnosed from *F. altocorpus*, *F. azpelicuetae*, *F. gianetii*, *F. gracilis* Regan, 1904, *F. hasemani* Eigenmann & Vance, 1917, *F. isbruckeri*, *F. jauruensis* Eigenmann & Vance, 1917, *F. myriodon* (Isbrücker, Britski, Nijssen & Ortega, 1983), *F. nattereri* Steindachner, 1910, *F. odontotumulus*, and *F. wuyugu* by the absence of the mid-dorsal

plate series *vs.* its presence. It is distinguished from *F. acus* (Kner, 1853), *F. amazonum*, *F. colombiensis*, *F. curtirostra* Myers, 1942, *F. gladiolus* (Günther, 1864), *F. martini*, *F. mitoupibo* Bellen, Urbano-Bonilla & Zamudio, 2016, *F. rugosa* Boeseman, 1971, *F. taphorni*, *F. venezuelensis* Martín Salazar, 1964, *F. vittata* Myers, 1942, and *F. yarigui* by a complete series of central abdominal plates (incomplete in 4.4% of the specimens) *vs.* incomplete series in *F. amazonum*, *F. curtirostra*, *F. gladiolus*, *F. mitoupibo*, *F. rugosa*, and *F. taphorni*, and series absent in *F. acus*, *F. colombiensis*, *F. martini*, *F. venezuelensis*, *F. vittata*, and *F. yarigui*. *Farlowella kirane* is also diagnosed from congeners, except *F. wuyjugu*, *F. curtirostra*, *F. taphorni*, *F. acus*, *F. martini*, *F. venezuelensis*, *F. vittata*, *F. colombiensis*, and *F. mariaelenae* by the coloration of the caudal fin in adults, in which



FIGURE 3 | Naked gular region of *Farlowella kirane*, NUP 10968, 87.7 mm SL, showing the diagnostic absence of plates. White line indicates the anterior limit of the plates covering the ventral portion of the body. Scale bar = 1 mm.

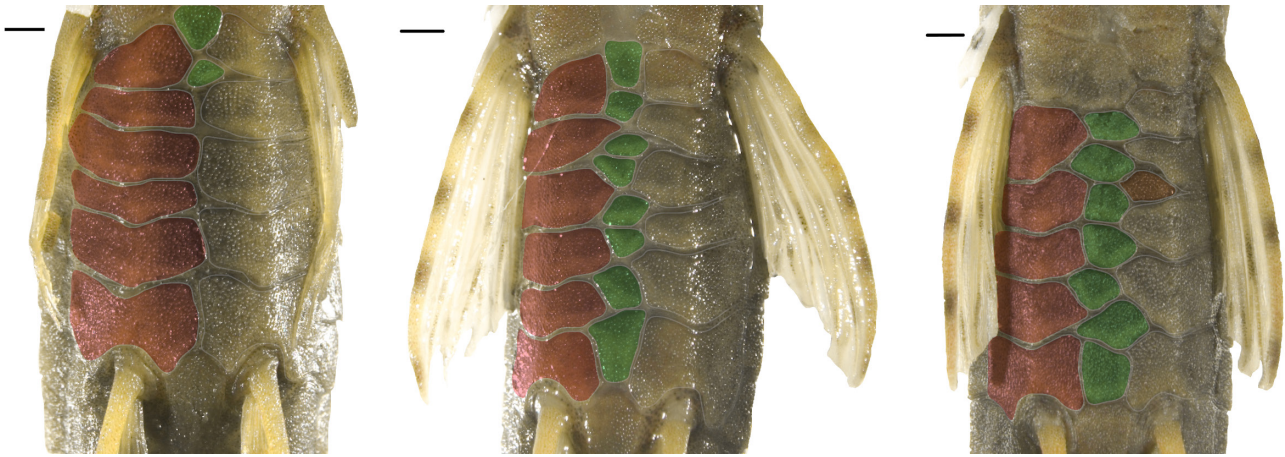


FIGURE 4 | Plates covering the abdomen of *Farlowella kirane*. From left to right: LBP 33961, 79.6 mm SL; NUP 10968, 83.5 mm SL; NUP 10968, 85.2 mm SL. The specimen in the left has the condition present in only 4.4% of the specimens, in which the midabdominal series (plates shaded in green) is incomplete. The series is complete in the other two specimens (as in 95.6% of the specimens). The specimen on the right has a plate (shaded in orange) that seems to result from the fragmentation of one of the left-side lateral abdominal plates. Right-side lateral abdominal plates are shaded in reddish pink. Scale bars = 1 mm.

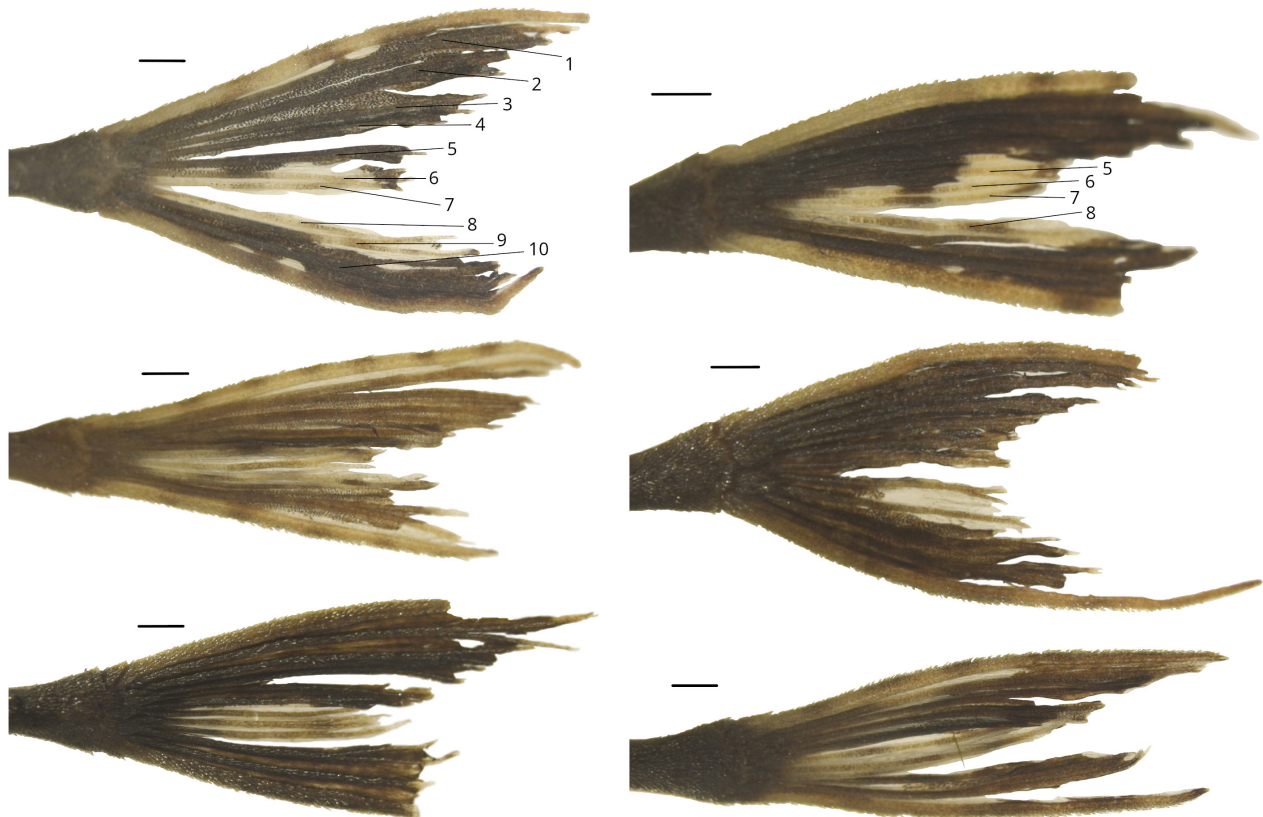


FIGURE 5 | Polymorphism in the caudal-fin coloration of *Farlowella kirane*. From left to right, from top down: holotype, MNRJ 55993, 95.9 mm SL; NUP 10968, 78.9 mm SL; 76.9 mm SL; 85.8 mm SL; not measured; and 91.8 mm SL. Dorsal-lobe fin rays (usually rays 1–5) and interradial membranes are invariably dark colored (as well as lower ventral-lobe rays; usually rays 9–10), although unpigmented patches may be present. Dorsal portion of the ventral lobe (usually rays 6–8) and interradial membranes are light colored, although their bases are variably covered by melanophores. Scale bars = 1 mm.

from the 1st to the 5th branched rays (*i.e.*, all dorsal-lobe rays; Fig. 5) and the interradiar membranes are densely covered by melanophores, as well as the 9th and 10th rays and the membrane in between (*i.e.*, the ventral portion of the ventral caudal-fin lobe), while the remaining branched rays and membranes are mostly unpigmented *vs.* symmetrical coloration of the caudal fin in *F. altocorpus*, *F. amazonum*, *F. azpelicuetae*, *F. gianetii*, *F. gladiolus*, *F. gracilis*, *F. hasemani*, *F. henriquei* Miranda Ribeiro, 1918, *F. isbruckeri*, *F. jauruensis*, *F. myriodon*, *F. nattereri*, *F. odontotumulus*, and *F. rugosa*, with a stripe of variable width running from the base of the fin to the tip of each lobe, occasionally interrupted; a dark stripe on the dorsal lobe and no conspicuous mark on the ventral lobe in *F. smithi* Fowler, 1913; and a dark stripe occupying most of the dorsal caudal-fin lobe and a black spot on the distal portion of the ventral lobe, not connected to the pigmented area on the base of the fin in *F. hahni* Meinken, 1937, *F. knerii* (Steindachner, 1882), *F. oxyrryncha* (Kner, 1853), *F. paraguayensis*, *F. reticulata* Boeseman, 1971, and *F. schreitmuelleri* Arnold, 1936. Additionally, the new species can be distinguished from other short-snouted species in the Paraguai River basin by the total pelvic-fin rays consisting in four or five *vs.* six in *F. jauruensis* and *F. paraguayensis*; by having modally i,10,i rays on caudal fin *vs.* i,12,i in *F. jauruensis* and i,11,i in *F. paraguayensis* (Tab. 4); by the color pattern of snout consisting of dark pigment only laterally *vs.* snout completely dark in *F. jauruensis*.

Description. Dorsal, lateral, and ventral views of holotype in Fig. 1. Morphometric data for holotype and paratypes summarized in Tab. 3. Maximum standard length 95.9 mm SL. Body depressed and slender, completely covered with dermal plates, except at tip of snout and on gular region. Contour of head with deep concavity at transition between ‘cheek’ and rostrum. Rostrum slender and flat ventrally, its tip with naked area (*i.e.*, not covered by plates); naked area ranging from circular to approximately U-shaped in anterior view. Plated area of snout perforated by pores dorsally and ventrally.

Dorsal profile of rostrum nearly straight, its tip slightly upturned; dorsal profile of head nearly straight to interorbital region; convex immediately posterior to eye (bulge on anterior portion of parieto-supraoccipital), thence nearly straight, slightly ascending to nuchal plate and ascending abruptly along nuchal plate. Dorsal-fin base profile slightly concave. Ventral profile slightly straight from snout tip to origin of anal fin, slightly concave at base of anal fin and straight profile to end of caudal peduncle.

Eyes round, not protuding, aligned to surface of head and located dorsolaterally, visible in dorsal view and not visible in ventral view, bordered anterodorsally by lateral ethmoid, with reduced contribution of frontal, dorsolaterally by sphenotic, and ventrally

TABLE 4 | Variable meristical data between *Farlowella kirane* and other short-snouted species from the Paraguai River basin.

Species	Lateral series of plates		Total Pelvic-fin rays			Caudal-fin rays				
	4	5	4	5	6	i,8,i	i,9,i	i,10,i	i,11,i	i,12,i
<i>Farlowella kirane</i>	159*		24	150*		1	6	145*		1
<i>Farlowella jauruensis</i>		7		1	6					7
<i>Farlowella paraguayensis</i>	139				139				139	

by infraorbital series. Skin flap around anterior nostril, in very short tube, posteriorly with triangular projection, medially continuous with skin flap around posterior nostril, longitudinally elongated. About 7–9 olfactory lamellae disposed on either side of central fold. Gill arches covered with numerous transversal, fleshy lamellae (Fig. 6) on both external and internal faces; lamellae also present internally to suspensorium, facing lamellae on first gill arch. Preopercular canal running directly from sphenotic to preopercle. Rectangular nasal, laterally curved; anterior extension present. Broad frontal; contacting anteriorly with nasal, anterolaterally in contact with lateral ethmoid, posterolaterally with sphenotic, and posteriorly with parieto-supraoccipital. Oval parieto-supraoccipital, contacting the first pre-dorsal plate posteriorly.

Shallow mid-dorsal keel from base of rostrum to transverse line between nostrils, indistinct in some specimens. Paired lateral keel shallow from the tip of rostrum to medial side of nostril, thence becoming slightly deeper and deflecting laterally, approximating supra-orbital canal; from that point, lateral keel deflected medially, almost meeting its counterpart at middle of parieto-supraoccipital; from that point, contralateral keels diverge again, then continue onto plates in dorsal series, fading before reaching vertical through dorsal-fin origin. Posterior margin of parieto-supraoccipital ranging from nearly straight to produced, shaped approximately as half hexagon (Fig. 1).

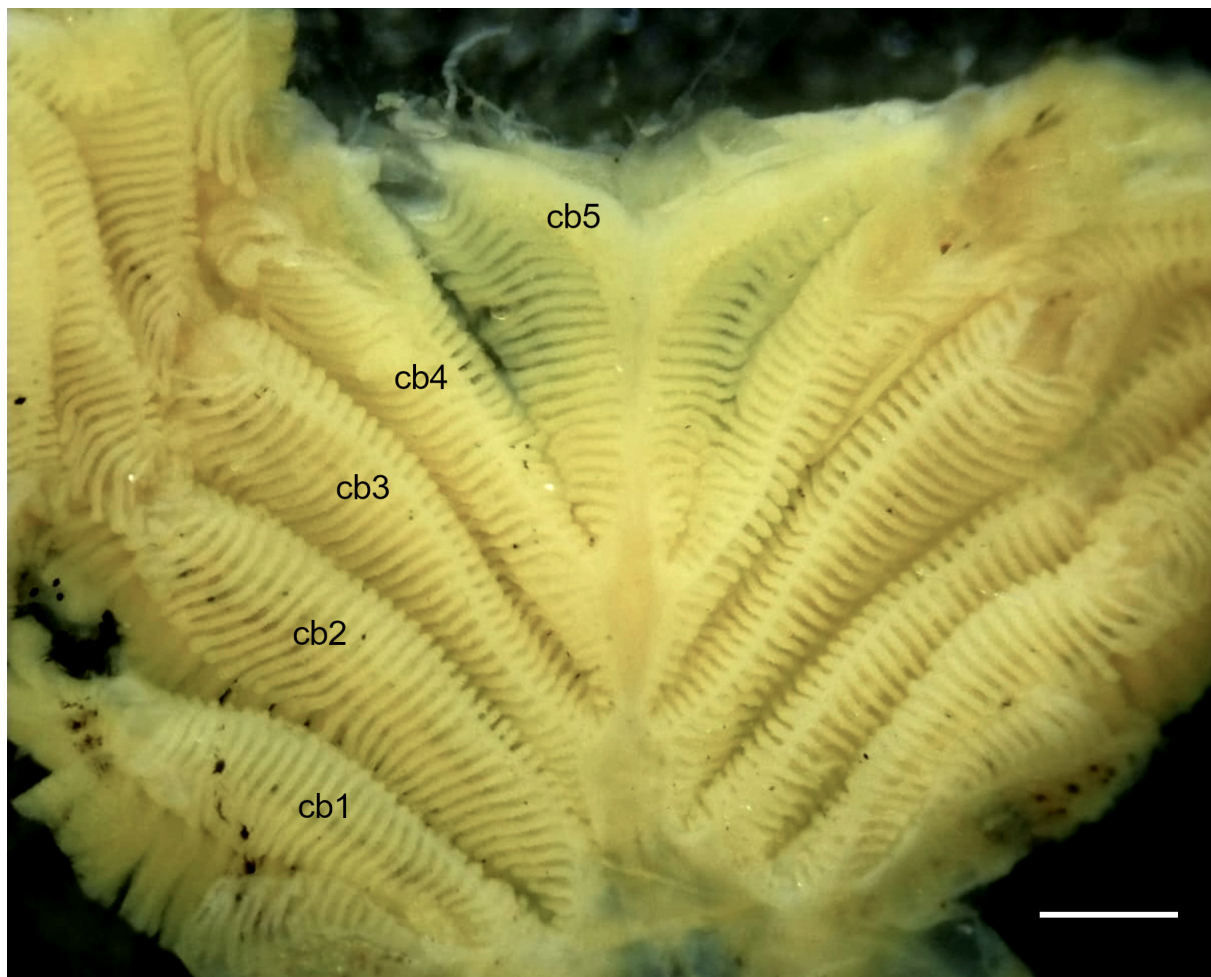


FIGURE 6 | Gill arches of *Farlowella kirane*, LBP 33961, 85.8 mm SL, in dorsal view, showing the fleshy transversal lamellae that cover each arch. Scale bar = 0.5 mm. cb = ceratobranchials.

Mouth ventrally positioned. Oral disc ovoid, lower lip longer than the upper lip. Upper lip with transversely elongated papillae, especially anteriorly to premaxillae. Lower lip with rounded papillae, largest anteriorly and medially, decreasing in size from oral opening to labial margin. Margin of both lips papillose; a few papillae reaching external face of lower lip. Small plates with odontodes on upper lip. Slender, bicuspid teeth; medial cusp larger than lateral cusp, spatulate. Each premaxilla with 14(1), 15(3), 16(2), 18(1), 19(1), 22(1), 23(1), 27(1), 32(1) teeth in young specimens; 29(1), 30(2), 31(4), 32(4), 33(4), 34*(4), 35(3), 36(3), 37(8), 38(2), 39(2), 40(1), 41(2), 42(1), 43(1), 44(2) teeth in adults (Fig. 7). Each dentary with 10(4), 11(1), 12(2), 13(1), 15(1), 18(1), 23(1), 24(1) teeth in young specimens; 19(2), 22(4), 23(3), 24(3), 25(5), 26(6), 28(5), 29*(2), 30(2), 31(1), 32(4), 33(3), 34(1), 35(1) teeth in adults (Fig. 7). Premaxilla larger than dentary. Maxillary barbel slightly protruding from mouth margin. Central buccal papilla present between posterior faces of premaxillae, with truncated distal margin, concave on its inner face (Fig. 3); width of central papilla from about one fourth to almost half length of premaxillary tooth series. Oral valve inserted posterior to proximal portion of premaxillae and reaching anterior face of dentaries; fleshy medial ridge on oral valve, immediately posterior to central buccal papilla.

Four lateral series of plates: dorsal, median, mid-ventral, and ventral (*i.e.*, mid-dorsal series absent). Total dorsal plates 29(1), 30(12), 31*(11), 32(1) (two abnormal specimens with 26 and 27); 0(12), 1*(6) plates separated from contralateral series by parieto-supraoccipital; 6(2), 7*(16) between parieto-supraoccipital and nuchal plate, adjacent to contralateral series; 1(2), 2*(16) separated from contralateral series by nuchal plate; 2*(17), 3(1) separated from contralateral series by dorsal fin; 17*(12), 18(4), 19(1) between dorsal fin and first procurent caudal fin ray, adjacent to contralateral series (one abnormal specimen with 15); 1(1), 2*(16) separated from contralateral series by caudal fin (one abnormal specimen with 0). Total predorsal plates 8(9), 9(12), 10*(5) (one abnormal specimen with 6). Total postdorsal plates 21*(13), 22(10), 23(3) (one abnormal specimen with 17).

Anterior median plates 12(2), 13*(20), 14(5). Ventromedian plates 13(2), 14*(19), 15(6). Posterior median plates 18*(11), 19(13), 20(2) (one abnormal specimen with 15) along the caudal region.

Total ventral plates 31(2), 32(10), 33(11), 34*(3) (one abnormal specimen with 30); 4(1), 5(25), 6(24), 7*(4) lateral abdominal plates on either side; 1(1), 2*(14), 3(3) plates between last lateral abdominal plate and peri-anal plate; 1*(18) perianal plate; 2*(15), 3(3) plates between perianal plate and first plate lateral to anal fin (usually separated from contralateral series by pre-anal fin plate); 1(2), 2*(16) plates lateral to anal fin (and separated from contralateral series); 18*(14), 19(3) between anal fin and first procurent caudal-fin ray (one abnormal specimen with 16); 1(1), 2*(16) plates separated from contralateral series by caudal fin (one abnormal specimen with 0). Total postanal plates 21(5), 22*(19), 23(2) (one abnormal specimen with 18).

One plate on base of each caudal-fin lobe* (26); plate on base of median caudal-fin rays, continuing median series, 0(21), 1*(5).

One midabdominal series of plates in all specimens. Continuous* (152) midabdominal series with 5(2), 6(4), 7(7), 8(3), 9*(5), 10(1) plates, starting medial to first lateral abdominal plate and ending medial to last lateral abdominal plate, immediately anteriorly to inter-pelvic plate (occasionally interrupted just by a small projection of a lateral abdominal

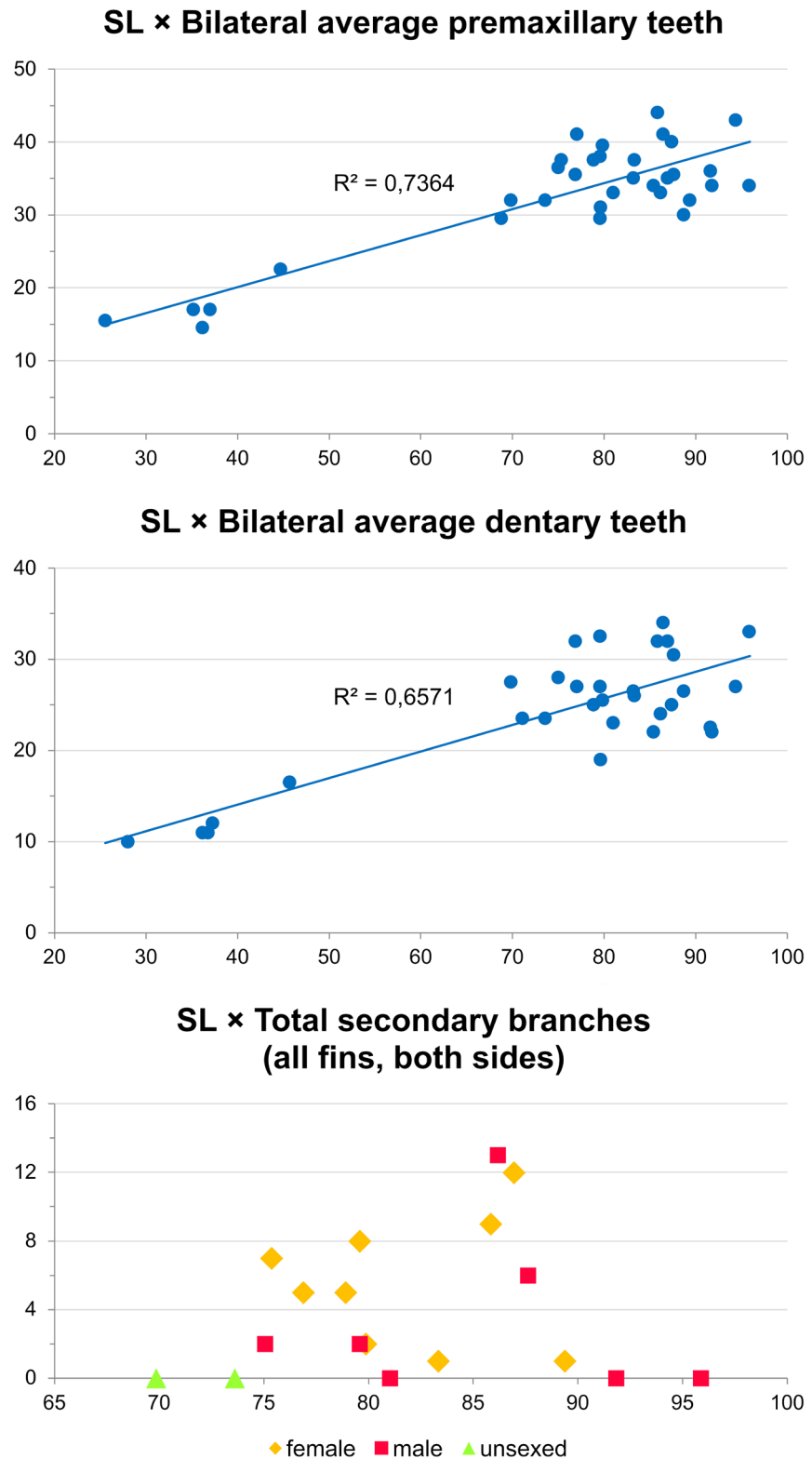


FIGURE 7 | *Farlowella kirane*, allometric characters. Each point represents the bilateral average of one individual, in the case of premaxillary and dentary teeth (top and middle charts). In the bottom chart, each point represents the sum of all secondary branching points from all fins.

plate); or midabdominal series incomplete (7), with 2(2), 7(2) plates, but interrupted by the medial meeting of 3 or 4 lateral abdominal plates.

Bony ring around cloaca elliptical, longitudinal axis longer; pre-anal plate usually forming relatively large portion of bony ring (otherwise formed by peri-anal plates), but forming smaller portion of bony ring in some specimens.

First ray of each fin (not counting procurent rays) thicker than remaining rays; first pelvic-fin ray thicker than first rays of remaining fins. Pectoral-fin rays i,3,i(1), i,4,i(7), i,4,ii(2), i,5*(2), i,5,i(25), i,6(9); slightly concave posterior margin; unbranched ray slightly shorter to slightly longer than first branched ray; pectoral fin reaching up to half of abdomen, its tip reaching short distance from pelvic-fin origin to slightly surpassing it. Dorsal-fin rays i,4,ii(1), i,5,i*(12), i,6(14); straight to slightly concave posterior margin; unbranched ray slightly shorter to slightly longer than first branched ray. Pelvic-fin rays i,2,i(17), i,2,ii(8), i,3(7), i,3,i*(133), i,4(9); straight posterior margin; unbranched ray slightly shorter to slightly longer than first branched ray, its tip almost reaching posterior end of peri-anal plate. Anal-fin rays i,4,i(3), i,5*(24); straight to slightly concave posterior margin; unbranched ray slightly shorter to slightly longer than first branched ray. Base of first anal-fin ray anterior to vertical through base of first dorsal-fin ray (1 specimen), with base of second anal-fin ray aligned with first dorsal-fin ray; or base of first anal-fin ray at vertical through base of 1st dorsal-fin ray (1), between bases of 1st and 2nd (4), through base of 2nd (6), between bases of 2nd and 3rd (2), through base of 3rd (3), or between bases of 3rd and 4th (1). Caudal fin rays i,8,i(1), i,9,i(6), i,10,i*(145) [distinctly abnormal fins with i,3,i(1), i,4,i(1), i,7,i(2), i,12,i(1)]; deeply concave posterior margin; dorsal lobe slightly longer than the ventral lobe. Filament on dorsal unbranched ray of caudal fin absent or barely projecting beyond dorsalmost branched ray* (28) or projecting to variable distance beyond dorsalmost branched ray (18; slightly more frequently in males), its length always distinctly shorter than half total length of unbranched ray. Filament on ventral unbranched ray of caudal fin absent or barely projecting beyond ventralmost branched ray* (47) or projecting a variable distance beyond ventralmost branched ray (20; slightly more frequently in males), its length always distinctly shorter than half total length of unbranched ray, and usually shorter than length of dorsal filament. Most specimens with tip of unbranched caudal-fin rays broken. All fin rays with odontodes; more developed odontodes on first unbranched ray.

Coloration in alcohol. General coloration dark brown on dorsal side. Upper lip beige with light-brown stripe bordering edge; lower lip beige; maxillary barbels beige with light brown chromatophores. Ventral coloration yellow to light brown from anterior region of upper lip to anterior edge of anal fin; ventral coloration from anal-fin region to caudal fin light-brown. Dorsal and median plates brown; ventromedial and ventral plates beige; area of posterior median plates brown, with posterior edge of each posterior median plate yellowish. One conspicuous dark-brown stripe from snout tip to dorsal fin, blending with dark brown coloration on posterior region of caudal peduncle. Infraorbital region, including infraorbital series, opercular series, and cleithrum, beige with few diffusely scattered brown chromatophores. Pectoral fin hyaline with some scattered chromatophores on rays, more concentrated on distal portion of first two rays. Dorsal fin hyaline with scattered chromatophores on rays. Pelvic fin hyaline with

a few chromatophores on first rays. Anal fin hyaline, with scattered chromatophores on rays, more concentrated and diffuse on distal portion of first two rays and on proximal portion of last ray. Dorsal lobe of caudal fin with brown stripe on rays and membranes, few hyaline ocelli on rays of the dorsal distal region. Ventral lobe of caudal fin with hyaline membrane with three to four outermost rays dark-brown from base to distal portion of fin. No significant differences between color pattern of specimens in life and in alcohol (Fig. 2).

Sexual dimorphism and ontogeny. The caudal-fin coloration is allochromatic, so that the smallest specimens analyzed have either an elongate spot or a stripe extending from the base of the fin towards its distal margin, slightly biased towards the dorsal lobe. As the fish grows, that spot or stripe grows to occupy all branched rays in the dorsal lobe, while another stripe seems to develop from the base of the fin towards the tip of the ventral lobe, thus originating the typical coloration seen in adults (Fig. 5).

The number of teeth varies allometrically, as seen in Fig. 7. Allometry also seems to be present in the number of secondary branching points on fin rays. Young specimens have no secondary branches on any fin rays, while up to 13 secondary branching points were observed in adults (counted on all fins, on both sides of the fish). However, the correlation is not very consistent, since a few large specimens (including the holotype) have no secondary branches. A neat correlation was observed between SL and HL, which is a negatively allometric character (Fig. 8). A less consistent correlation was found between sex and HL, in which males tend to have larger heads, although almost half the males fall within the range observed in females (Fig. 8). No breeding odontodes were observed. Males, as well as the young, have the cloaca almost tubular, its aperture turned posteroventrally. In turn, females have the cloaca similar to a pouch, its aperture turned anteroventrally (Fig. 9).

Geographical distribution. *Farlowella kirane* is known only from the Sepotuba River basin, upper Paraguai River basin, Mato Grosso State, Brazil (Figs. 10–11).

Etymology. The Paresi people inhabited the plateau called Parecis, from the Arinos River and headwaters of Paraguai River to the headwaters of the Guaporé and Juruena Rivers. Specifically, these rivers spread across the valley of the Sumidouro River, a tributary of the Arinos River, and headwaters of the Sepotuba and Sacuriu-iná Rivers, approximately the same area of occurrence of the new species (Povos Indígenas no Brasil, 2009). In the language of the Paresi, which is from the Aruak family linguistic trunk, *kirane* means small (Rowan, 2001). The species name alludes to the fact that *Farlowella kirane* is the smallest species known to date in the genus, reaching up to 96 mm SL.

Conservation status. The new species is known from populations in Sepotuba River, Paraguai River basin, Mato Grosso State, Brazil (Figs. 10–11). Considering the currently available data, there is no plausible detected threat to the new species, and according to the International Union for Conservation of Nature (IUCN) categories and criteria (IUCN, 2024), *Farlowella kirane* can be classified as Least Concern (LC).

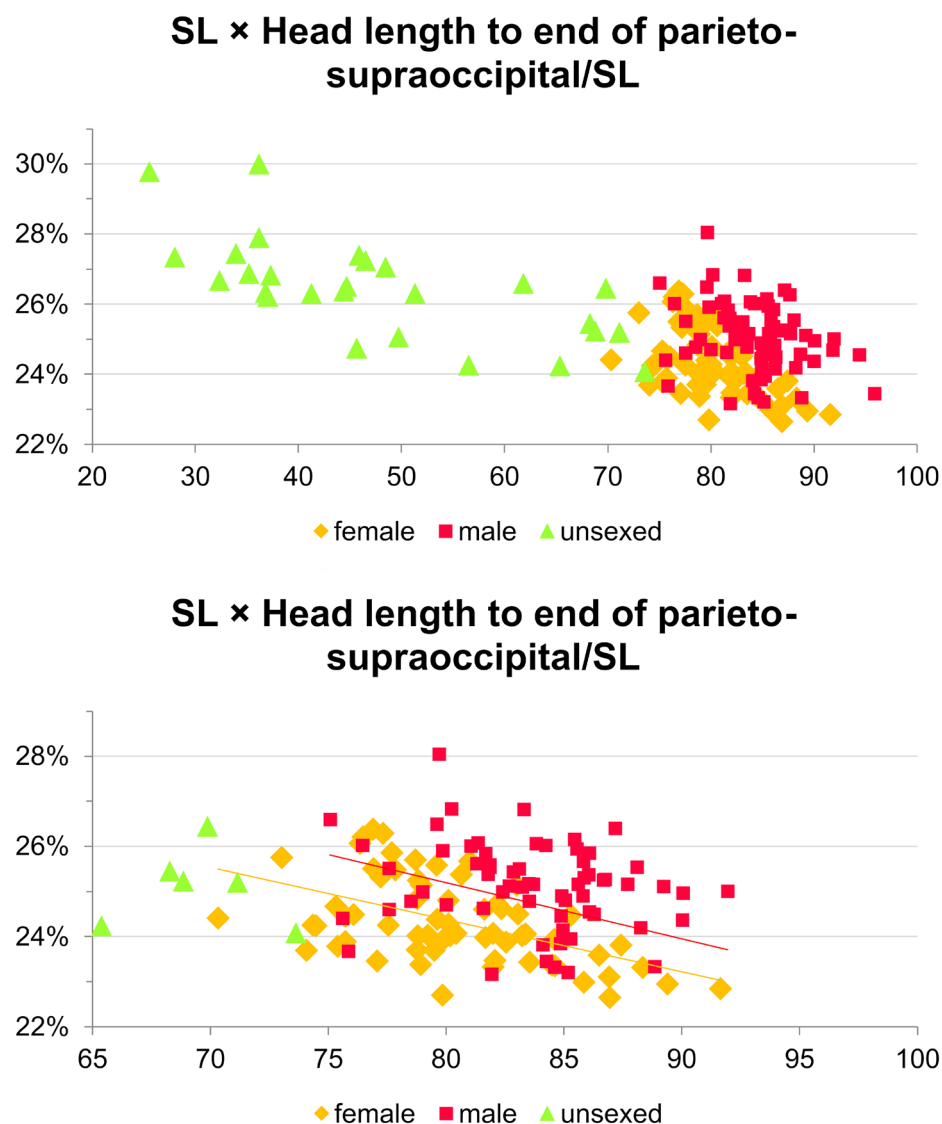


FIGURE 8 | Allometry and sexual dimorphism in the head length of *Farlowella kirane*. Both graphs show the same correlation, but bottom graph focuses on adult specimens to emphasize sexual dimorphism.

Molecular species delimitation. The ABGD recognized 12 independent lineages, the GMYC recognized 13 independent lineages, and the PTP results estimated 14 lineages (Fig. 12). All three analyses recovered *F. kirane* as an independent lineage. The genetic divergences between *F. kirane* and other *Farlowella* lineages ranged from 3.1% to 12.5% (Tab. 5). *Farlowella kirane* presented the lowest genetic distance from *F. wuyjugu* (3.1%) and the highest distance from *F. curtirostra* (12.5%).

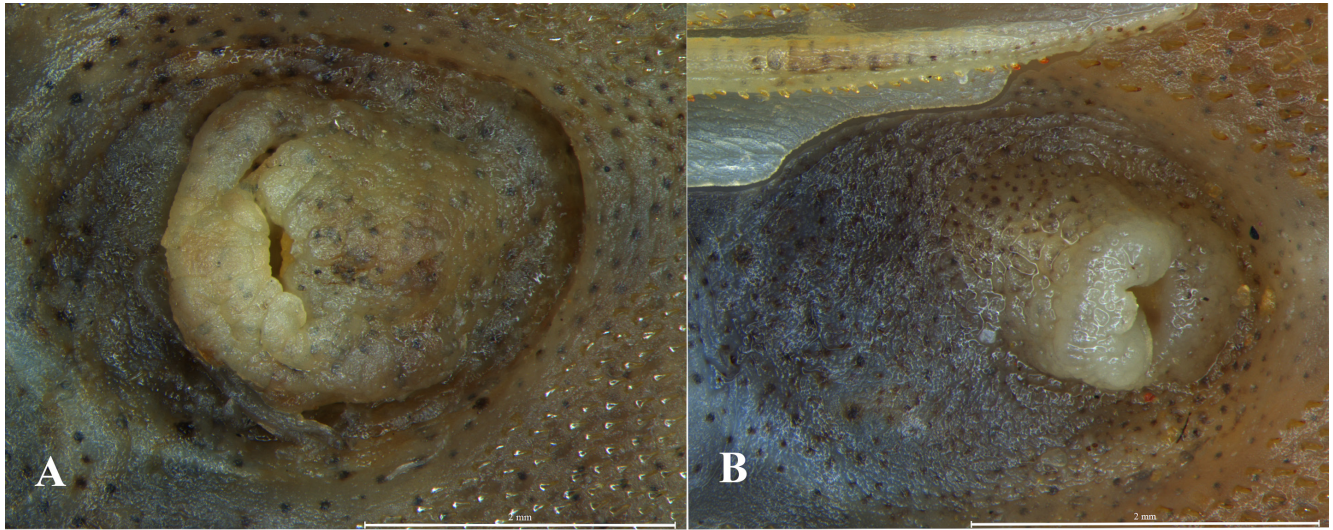


FIGURE 9 | Sexual dimorphism in the cloaca of *Farlowella kirane*. A. LBP 8556, 86.5 mm SL, female; B. LBP 8413, 88.7 mm SL, male. Scale bars = 2 mm.

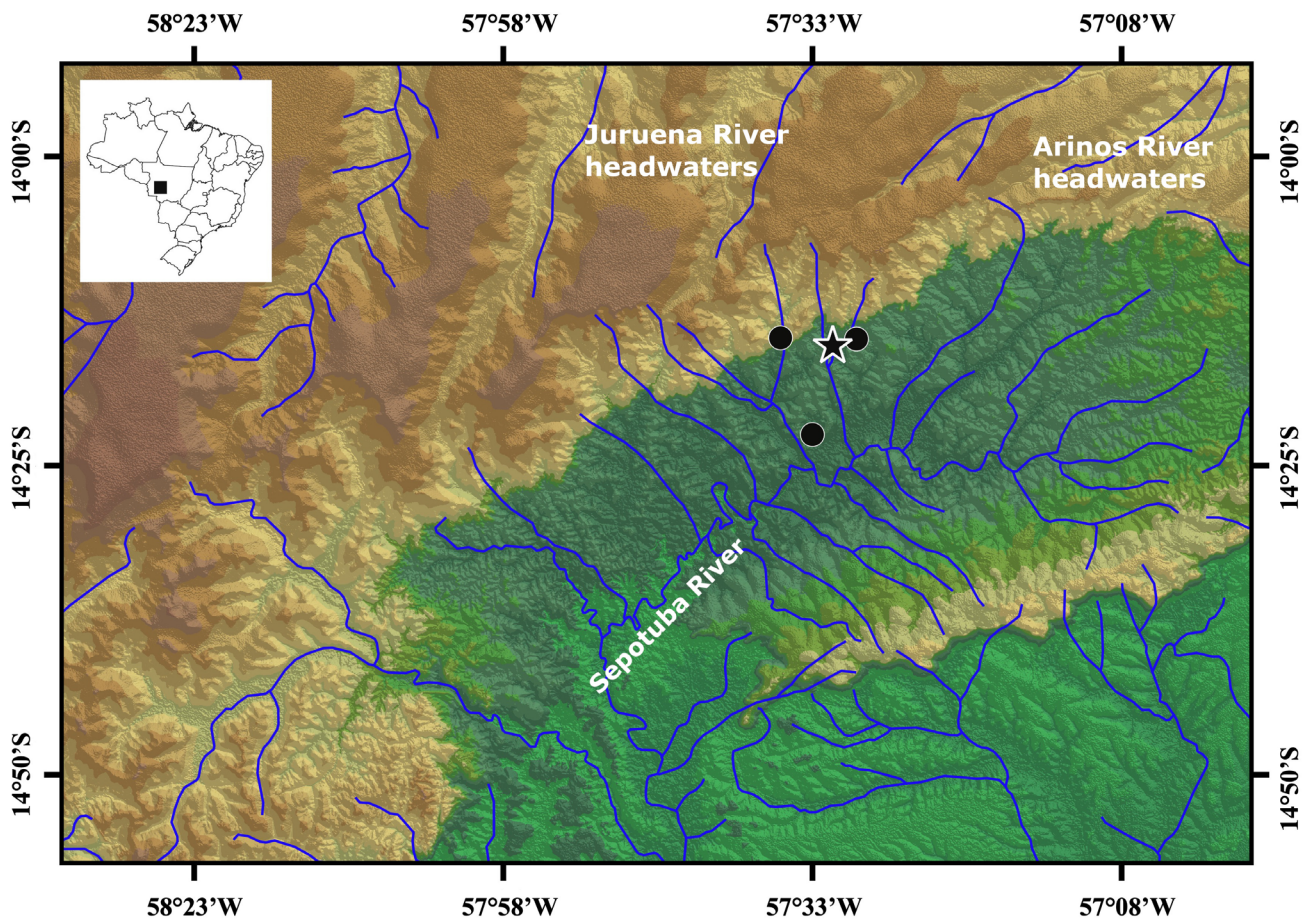


FIGURE 10 | Map showing the geographic distribution of *Farlowella kirane* (star for type-locality), Sepotuba River basin, upper Paraguai River basin.



FIGURE 11 | Córrego das Pedras, tributary to Córrego Vermelho, Sepotuba River basin, Paraguai River basin, 14°21'03"S 57°33'07"W, type-locality of *Farlowella kirane*.

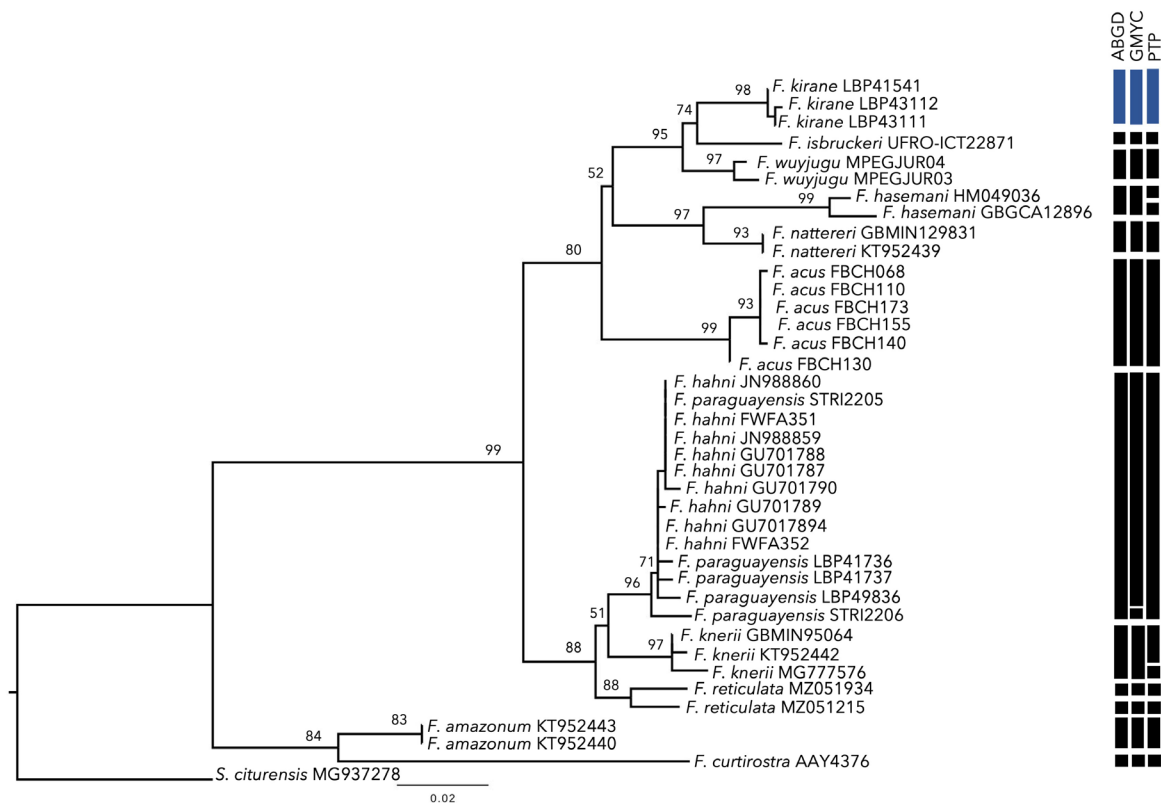


FIGURE 12 | Maximum likelihood tree of *Farlowella* using cytochrome c oxidase subunit I (COI; 39 sequences with 611 bp) and results of the molecular delimitations methods represented (ABGD, GMYC and PTP). Numbers at nodes represent bootstrap support.

TABLE 5 | Matrix of interspecific K2P genetic distance among groups of *Farlowella* used in the present study.

	<i>F. kirane</i>	<i>F. acus</i>	<i>F. amazonum</i>	<i>F. curtirostra</i>	<i>F. hahni/F. paraguayensis</i>	<i>F. hasemani</i>	<i>F. isbruckeri</i>	<i>F. knerii</i>	<i>F. nattereri</i>	<i>F. reticulata</i>	<i>F. wuyjugu</i>
<i>F. kirane</i>											
<i>F. acus</i>	0.057										
<i>F. amazonum</i>	0.099	0.099									
<i>F. curtirostra</i>	0.125	0.117	0.071								
<i>F. hahni/F. paraguayensis</i>	0.075	0.068	0.096	0.120							
<i>F. hasemani</i>	0.072	0.067	0.109	0.126	0.077						
<i>F. isbruckeri</i>	0.033	0.058	0.108	0.125	0.069	0.071					
<i>F. knerii</i>	0.070	0.066	0.092	0.114	0.027	0.079	0.064				
<i>F. nattereri</i>	0.058	0.058	0.098	0.129	0.068	0.041	0.061	0.070			
<i>F. reticulata</i>	0.075	0.071	0.094	0.112	0.033	0.082	0.068	0.036	0.072		
<i>F. wuyjugu</i>	0.031	0.058	0.099	0.125	0.070	0.069	0.034	0.066	0.052	0.068	

DISCUSSION

Farlowella kirane can be differentiated from all other congeners by a combination of character states described in the revision of the genus by Retzer, Page (1996), such as a complete mid-dorsal series of plates; a complete midabdominal series; a rostrum of median length; an asymmetrical caudal-fin coloration, in which there is no isolated dark spot on the tip of the ventral lobe; the absence of a very dark reticulated pattern on the head and snout; and the absence of breeding odontodes. However, the easiest way to identify the species is the absence of gular plates and a small number of pelvic- and caudal-fin rays.

The absence of gular plates in *Farlowella* was first reported by Dopazo *et al.* (2023) for *F. wuyjugu*. This character is up to now apparently restricted to *F. wuyjugu* and *F. kirane*. Few pelvic- and caudal-fin rays were reported by Ballen *et al.* (2016) for *F. gianetii*, but few authors have reported the number of those rays in other species of *Farlowella*. Notably, no fin-ray counts were mentioned by Retzer, Page (1996), so the number of rays found in most species is unknown in the published literature (also notably, those authors provided no table of measurements, which make comparisons among *Farlowella* species more difficult). However, preliminary analyses indicate that the number of rays in the pelvic and caudal fins may be informative in differentiating species in the genus.

Regarding the number of caudal-fin rays, in particular, it is worth mentioning that the presence of 11 or 12 branched rays was listed in the key of Covain, Fisch-Muller (2007) as one of the character states distinguishing their Harttiini (which included *Farlowella*) from other Loricariinae. Covain, Van der Sleen (2018) repeated the same number in their identification key to the genera of Loricariinae occurring in the AOG Region (Amazon and Orinoco basins and the Guianas), despite the fact that the presence of 10 branched rays had already been reported by Isbrücker *et al.* (1983).

Farlowella kirane does not have breeding reproductive odontodes on the head and trunk of mature males. Additional species, of which no specimens with breeding

odontodes are known, are *F. altocorpus*, *F. azpelicuetae*, *F. gianetii*, *F. jauruensis*, and *F. wuyjugu*. In the case of *F. wuyjugu*, several mature males were analyzed, and the fact that none bore breeding odontodes is strong evidence that those structures really are absent in that species, as they are in *F. kirane*. As for *F. altocorpus*, *F. azpelicuetae*, *F. gianetii*, and *F. jauruensis*, we cannot be sure if breeding odontodes are absent in those species or they are present, just not in the available specimens.

The study led to the discovery of a sexually dimorphic character related to the shape of the cloaca, made simultaneously by Melo-Ortiz *et al.* (2024). Although this condition has been reported in more than one species of *Farlowella*, we have not yet confirmed the distribution of that sexual dimorphism in all species of *Farlowella*, nor in other genera of Loricariinae. Thus, many more specimens must be analyzed to understand at which level that character state is diagnostic. Likewise, it was here identified allomeric, allometric, and allochromatic characters in *F. kirane*. The diagnostic power of these characters remains poorly known.

Retzer, Page (1996, figs. 8–11) first reported a positively allomeric number of teeth in both *F. vittata* and *F. mariaelenae*, as well as a negatively allometric snout-mouth length in both species. Those results agree with that observed in *F. kirane*. On the other hand, these authors observed that females of *F. vittata* have larger heads than the males, while the opposite was observed in *F. kirane*. Delgadillo *et al.* (2021, fig. 2) showed that in the species described therein (name unavailable for not complying with the Code) the snout mouth/HL ratio grows larger with increasing SL.

All facts discussed above show the importance of finding new morphologic characters to help diagnosing species of *Farlowella*. Because of that, we described and analyzed the shape of the central buccal papilla and of the posterior margin of the parieto-supraoccipital, the olfactory lamellae, the relative positions between the anal and dorsal fins, and the shape of the gill arches. Gill arches are rarely examined in loricariids because, to do that, it is necessary to dissect the specimens. We hypothesize that, due to their shape, the lamellae covering the gill arches may play a role in turning grazed algae into a food bolus, to facilitate their ingestion. Similar adaptations for consuming very small food particles are present in filter-feeders and in substrate-sifters, such as many Geophagini. Another newly described character is related to the composition of the bony ring around the cloaca, which in *F. kirane* is formed by the pre-anal plate anteriorly, while we have observed that in some other species it is entirely formed by the peri-anal plate. Because that character was discovered when this work was already advanced, we were not able to check all congeners for the character states present in each of them.

In addition to *F. kirane*, other *Farlowella* species such as *F. amazonum*, *F. hahni*, *F. isbruckeri*, *F. jauruensis*, and *F. paraguayensis* have been recorded for the Paraguai River basin (Retzer, Page, 1996; Britski *et al.*, 1999; Azpelicueta, Koerber, 2015; Tencatt *et al.*, 2022). However, there are some inconsistencies regarding the occurrence of *F. amazonum* and *F. isbruckeri*. The occurrence of *F. amazonum* in the Paraguai River basin has already been discussed in the literature (Retzer, Page, 1996; Britski *et al.*, 1999; Azpelicueta, Koerber, 2015). Azpelicueta, Koerber (2015) have recently reported on the rediscovery of the holotype of *F. paranaense* Meiken, 1937 (= *F. amazonum*). As suggested by Azpelicueta, Koerber (2015), the occurrence of *F. amazonum* in the lower Paraná can be interpreted by three hypotheses: (1) wider preterit distribution, (2) erroneous (due to

mislabeling by Meinken) or (3) dispersal by aquatic vegetation during flooding. Only one additional specimen identified as *F. amazonum* was ever found in the Paraguai River basin: a specimen collected in Taquari River in 1979 (MZUSP 27717).

The occurrence of *F. isbruckeri* in the Paraguai River basin seems to be uncertain. Although Retzer, Page (1996) indicated that the species occurs exclusively in this basin, only the paratype is from the Paraguai River basin, and the holotype is from the Madeira River basin. The holotype (MZUSP 37641), mentioned as lost by Ballen *et al.* (2016) and found after a review of the *Farlowella* collection during the first author's doctoral studies, appears to be different from the paratype (MZUSP 27704). However, as the paratype examined consists of a faded specimen, it is not possible to determine whether they are the same species or different species, generating uncertainty about the occurrence of the species in the Paraguai River basin. In addition, an extensive review of material in collections did not identify *F. isbruckeri* in the Paraguai River basin, but in the Madeira River basin, reinforcing the inconsistency of its occurrence in the Paraguai River basin.

Consering *F. kirane*, seven species have been described from the Sepotuba River basin. Among these, both *Bario forestii* (Benine, Mariguela & Oliveira, 2009) and *Pimelodella taenioptera* Miranda Ribeiro, 1914 have been reported from many other localities in the Southern Neotropics, while *Curculionichthys paresi* (Roxo, Zawadzki & Troy, 2014), *Gephyrocharax machadoi* Ferreira, Faria, Ribeiro, Santana, Quagio-Grassiotto & Menezes, 2018, *Melanorivulus paresi* (Costa, 2008), and *Hemigrammus flavus* (Britzke, Troy, Oliveira & Benine, 2018) remain known only from the Sepotuba River basin. Despite the recent increase in species descriptions for the Sepotuba River basin, Krinski *et al.* (2015) did not list any *Farlowella* species in their inventory of the headwaters of the Sepotuba River. It is presently unknown whether the fish species endemic to the Sepotuba River are more closely related to other species in the Paraguai River basin or to those of the Amazon River basin. However, we noticed the presence, in the Sepotuba River, of species that are native to the upper Juruena River basin, such as *Characidium* cf. *etheostoma* Cope, 1872 (Crenuchidae), *Pyrrhulina marilynae* Netto-Ferreira & Marinho, 2013 (Lebiasinidae), *Knodus ytuanama* Ferreira & Ohara, 2023 (Stevardiidae), *Aequidens* cf. *gerciliae* Kullander, 1995 (Cichlidae), *Tatia aulopygia* (Kner, 1858) (Auchenipteridae), and *Astyanax* cf. *argyrimarginatus* Garutti, 1999 and *Hyphessobrycon heliacus* Moreira, Landim & Costa, 2002 (Acestrorhamphidae).

The molecular analysis carried out in this study included sequences available in public repositories, making it possible to update their identifications after examining most of the voucher specimens. In addition, samples of species related to *F. kirane* were incorporated, based on previous analyses using a more comprehensive database, as well as samples of another *Farlowella* species from the Paraguai River basin (*F. paraguayensis*). It was not possible to include samples of *F. jauruensis* due to the unavailability of tissues for genetic studies. As previously mentioned, this species is rarely found in collections or in the nature. In any case, future efforts such as the use of museum-based genomic approaches and sampling campaigns aimed at collecting new specimens are recommended.

Based on the data presented in this study, the genetic distances between the species analyzed ranged between 3.1% and 12.5%. The shortest distances were observed between *F. kirane* and the Amazonian species *F. wuyjugu* (3.1%), found in the Tapajós River basin, and *F. isbruckeri* (3.3%), from the Madeira River basin. The historical

relationship between the Amazon basin and the Paraguai basin has already been discussed by several authors (e.g., Dagosta, de Pinna, 2019). The shortest genetic distance observed between *F. kirane* and another species (*F. wuyjugu*) corresponds to the one with which it shares morphological similarities, such as the absence of plates in the gular region. In contrast, the greatest distance (12.5%) was recorded between *F. kirane* and *F. curtirostra*, a trans-Andean species that is morphologically and geographically very distinct from the new species.

In the molecular analyses of this study, *F. hahni* and *F. paraguayensis* appeared as a single MOTU. Indeed, the species are morphologically very similar, differing only in the size of the snout, in which *F. paraguayensis* has a relatively smaller snout. This can be a very variable character when analyzing different specimens along a sampling gradient. However, for taxonomic stability purposes, the vouchers from these basins were identified as these species. Nevertheless, a complete review of the genus is being conducted and future investigations including an increased number of samples from these localities should be conducted for a better understanding of these populations.

Comparative material examined. In addition to the comparative material listed in Dopazo *et al.* (2023), the following species were examined: *Farlowella acus*: Venezuela: NMW 47795, holotype, 159.6 mm SL. Colombia: IAvH-P 3855, 5, 129.7–174.9 mm SL; IAvH-P 3871, 2, 96.1–168.3 mm SL; IAvH-P 5082, 6, 58.4–111.1 mm SL. *Farlowella colombiensis*: Colombia: CZUT-IC 3324, 1, 144.4 mm SL; IAvH-P 22229, 2, 92.3–95.8 mm SL; ICN-MHN 17109, 3, 124.6–141.6 mm SL. *Farlowella amazonum*: Brazil: BMNH 1856.3.25.22, holotype, not measured; INPA 49953, 8, 64.7–101.0 mm SL; INPA 55228, 4, 77.6–95.8 mm SL; INPA 55843, 1, 59.9 mm SL; INPA 56084, 3, 73.7–85.6 mm SL; INPA 56255, 1, 66 mm SL; INPA 56387, 1, 74.2 mm SL; INPA 56716, 1, 147.7 mm SL; ZUEC-PIS 15176, 1, 90.9 mm SL; ZUEC-PIS 15450, 1, 179.7 mm SL; ZUEC-PIS 15516, 3, 113.6–171.5 mm SL; ZUEC-PIS 15652, 6, 81.5–184.9 mm SL; ZUEC-PIS 15681, 6, 154.5–198 mm SL. *Farlowella carinata*: Brazil: BMNH 1889.11.14.68, paralectotype, 153.6 mm SL. *Farlowella curtirostra*: Colombia: ANSP 200770, 1, 67.9 mm SL; CZUT-IC 19047, 2, 50.9–117.0 mm SL; CZUT-IC 19073, 1, 115 mm SL. *Farlowella gradiolus*: Brazil: BMNH 1853.3.19.66, lectotype, not measured; BMNH 1853.3.19.57, paralectotypes 2, 80.4–120.8 mm SL; ZUEC-PIS 12413, 1, 103.3 mm SL; ZUEC-PIS 14002, 1, 77.5 mm SL. *Farlowella gracilis*: Colombia: BMNH 1902.5.29.180, holotype, 177.1 mm SL; CZUT-IC 12055, 1, 112.1 mm SL; CZUT-IC 18402, 1, 148.5 mm SL; ICN-MHN 9434, 1, 120.5 mm SL; IAvH-P-2053, 1, 207.3 mm SL; ROM 107219, 3, 90.3–213 mm SL. *Farlowella hahni*: Argentina: ZMB 35296, syntypes, 2, 127.2–154.5 mm SL; Brazil: LBP 5217, 6, 88.8–155.1 mm CP; LBP 9617, 10, 59.1–135.6 mm SL; NUP 374, 6, 78.1–161.7 mm SL; NUP 818, 5, 127.6–140 mm SL; NUP 819, 10, 89.2–156.2 mm SL; NUP 1450, 1, 111.7 mm SL; NUP 1496, 5, 95.7–177.8 mm SL; NUP 2849, 1, 128.4 mm SL; NUP 4029, 2, 151.1–162.2 mm SL; NUP 4525, 1, 130.7 mm SL; NUP 4728, 5, 129.4–148.9 mm SL; NUP 7867, 2, 134.7–140.3 mm SL; NUP 11443, 1, 109.5 mm SL; NUP 13303, 2, 103.2–129.7 mm SL; NUP 14747, 1, 125.6 mm SL; NUP 16978, 2, 133.8–149.8 mm SL. *Farlowella isbruckeri*: Brazil: MZUSP 37641, holotype, 131.9 mm SL; MZUSP 27704, paratype, 134.3 mm SL; INPA 571, 4, 77.2–102.7 mm SL; INPA 3034, 47, 2 CS, 64.2–155.6 mm SL; INPA 3035, 16, 58.1–148.6 mm SL; MCP 36595, 1, 111.2 mm SL; MZUSP 126008, 1, 154.4 mm SL; UFRO-ICT 22871, 1, 140.1 mm SL. *Farlowella jauruensis*: Brazil: NUP 21372, 3, 56.4–80.4 mm SL. *Farlowella knerii*: Peru: NMW 47796, lectotype, 113.1 mm SL; NMW 76420, paralectotype, 107 mm SL; LBP 12549, 1, 172.9 mm SL. *Farlowella nattereri*: Brazil: NWM 46497, holotype, 96.1 mm SL; INPA 2392, 1, 192.2 mm SL; INPA 16216, 1, 67.1 mm SL; INPA 16221, 1, 73.3 mm SL; INPA 55320, 1, 100.5 mm SL; Colombia: IAvH-P 362, 2, 61–80.3 mm SL; IAvH-P 490, 2, 78.4–150.2 mm SL; IAvH-P 638, 1, 155.6 mm SL; IAvH-P 21247,

1, 178.6 mm SL. Guiana: ANSP 177284, 1, 183.5 mm SL; ANSP 179763, 2, 147.4–150 mm SL; ANSP 179764, 1, 173 mm SL. Peru: ANSP 182550, 1, 185.5 mm SL; LBP 22594, 1, 132.3 mm SL. *Farlowella oxyrryncha*: Brazil: NWM 47697, holotype, 172.8 mm SL; INPA 3035, 4, 101.4–116.1 mm SL; INPA 8208, 2, 67.2–101.4 mm SL; INPA 33471, 2, 59.1–94.7 mm SL; MNRJ 27509, 9, 3 CS, 47.7–131 mm SL; MNRJ 46119, 1, 131.4 mm SL; UFRGS 12165, 4, 94.7–105.5 mm SL; UFRGS 12325, 5, 49.8–133.6 mm SL; UFRGS 21842, 1, 100.3 mm SL; UFRO-ICT 10778, 3, 60.4–130.9 mm SL; UFRO-ICT 14301, 1, 101.4 mm SL. *Farlowella paraguayensis*: Brazil: INPA 567, 5, 72.3–122.2 mm SL; INPA 2829, 4, 65.1–135 mm SL; INPA 2830, 6, 70.5–153.2 mm SL; MCP 36591, 1, 66.9 mm SL; MNRJ 20328, 1, 62.7 mm SL; MNRJ 40585, 18, 2 c&s, 101–180.2 mm SL; MNRJ 44901, 1, 130 mm SL; MNRJ 46680, 2, 117.8–118.3 mm SL; MZUSP 43628, 2, 84.6–122.2 mm SL; MZUSP 44356, 4, 49.8–74.4 mm SL; MZUSP 44472, 6, 63.2–141.4 mm SL; MZUSP 59738, 23, 63.7–144.3 mm SL; MZUSP 59654, 22, 67–109.9 mm SL; MZUSP 59666, 1, 147.7 mm SL; MZUSP 59733, 1, 89.1 mm SL; MZUSP 78782, 5, 46.7–130.7 mm SL; MZUSP 91054, 2, 32.7–81.9 mm SL; MZUSP 115601, 9, 64.8–106 mm SL; MZUSP 120421, 5, 47.6–99.4 mm SL; MZUSP 125366, 5, 64.9–130.3 mm SL; MZUEL 9037, 5, 56.6–131 mm SL; MZUEL 9669, 1, 47.2 mm SL; NUP 21531, 5, 56.4–101 mm SL; ZUFMS-PIS 446, 1, 138.4 mm SL; ZUFMS-PIS 1292, 2, 134.63–143.35 mm SL; ZUFMS-PIS 1426, 3, 112.9–122.3 mm SL; ZUFMS-PIS 2809, 5, 117.35–154 mm SL; ZUFMS-PIS 3883, 1, 167.9 mm SL; ZUFMS-PIS 4373, 3, 113.7–128.4 mm SL; ZUFMS-PIS 4433, 7, 102.2–128.5 mm SL; ZUFMS-PIS 4488, 1, 79.2 mm SL; ZUFMS-PIS 5848, 1, 69.9 mm SL; ZUFMS-PIS 5950, 4, 2 CS, 74.2–112.9 mm SL; ZUFMS-PIS 6349, 1, 119.2 mm SL. Paraguay: MZUSP 54234, 1, 81.4 mm SL; MZUSP 100925, 1, 156.5 mm SL. *Farlowella paranaense*: Argentina: ZMB 33788, holotype, 131.7 mm SL, synonymy of *Farlowella amazonum*. *Farlowella pseudogladiolus*: Brazil: NMW 46498, holotype, 104.6 mm SL, synonymy of *Farlowella amazonum*. *Farlowella reticulata*: ZMA.PISC.106.174, lectotype, 110 mm SL; ZMA.PISC.106.932, 2, paralectotypes, 94.2–117.4 mm SL; Brazil: IEPA 2708, 1, 59 mm SL; IEPA 4644, 1, 66.9 mm SL; IEPA 4708, 1, 63.1 mm SL; IEPA 4724, 2, 80.1–121.8 mm SL; IEPA 4724, 6, 63.2–120.6 mm SL. *Farlowella venezuelensis*: ZMA.PISC.116.482, 1, paralectotype, 150.1 mm SL. *Farlowella yarigui*: Colombia: ICN-MHN 17819, 1, holotype, 113.9 mm SL; ICN-MHN 18889, 2, paratypes, 26.3–44.6 mm SL; ICN-MHN 17789, 2, paratypes, 76.4–77.8 mm SL; ICN-MHN 16020, 2, 80.4–81.6 mm SL; ICN-MHN 16021, 5, 45.8–73.1 mm SL; IAvH-P 17719, 3, 26.5–70.7 mm SL; IAvH-P 17736, 4, 46.2–69.3 mm SL; IAvH-P 17750, 9, 40.3–76.9 mm SL; IAvH-P 17761, 11, 45.9–92.7 mm SL; IAvH-P 17773, 22, 22.4–100.5 mm SL; IAvH-P 17797, 3, 45.6–52.5 mm SL.

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DATA AVAILABILITY STATEMENT

The authors confirm that the data supporting the findings of this study are available within the article.

COMPETING INTERESTS

The authors declare no competing interests.

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