Neotropical Ichthyology

Original article

https://doi.org/10.1590/1982-0224-2023-0112

urn:lsid:zoobank.org:pub:95847932-0AAA-4024-8BB3-69684368D313

A new long-snouted *Corydoras* (Siluriformes: Callichthyidae) from the rio Xingu and rio Tapajós basins, Brazilian Amazon

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A new species of *Corydoras* is described from the rio Xingu and rio Tapajós basins, Pará State, Brazil. The new species can be promptly distinguished from its congeners by the combination of the following features: (I) temporal sensory canal at sphenotic with two pores; (II) upper tooth plate of branchial arch with three or four series of teeth; (III) area at the corner of the mouth, ventral to the maxillary barbel, with a small, roughly triangular fleshy flap, not forming an elongated barbel-like structure; (IV) contact between posterior process of the parieto-supraoccipital and nuchal plate; (V) dark stripe transversally crossing the orbit, forming a mask-like blotch; (VI) absence of a distinct color pattern along midline of flank; (VII) dorsolateral body plates only with small, irregular, rounded or vertically elongated dark brown or black blotches; ground color of plates typically dusky but not forming large, conspicuous black patches; and (VIII) absence of a relatively large, conspicuous dark patch on anterior portion of dorsal fin.

Keywords: Corydoradinae, *Corydoras* sp. CW83, Jacareacanga, Taxonomy, Volta Grande do Xingu.

Submitted October 10, 2023
Accepted November 21, 2023
by Claudio Oliveira
Epub February 12, 2024

Online version ISSN 1982-0224
Print version ISSN 1679-6225

Neotrop. Ichthyol.
vol. 22, no. 1, Maringá 2024

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Uma espécie nova de *Corydoras* é descrita das bacias do rio Xingu e do rio Tapajós, Estado do Pará, Brasil. A espécie nova pode ser prontamente diferenciada de suas congêneres pela combinação das seguintes características: (I) canal sensorial temporal no esfenótico com dois poros; (II) placa dentária superior do arco branquial com três ou quatro séries de dentes; (III) área no canto da boca, ventralmente ao barbilhão maxilar, com pequena aba carnosa algo triangular, não formando uma estrutura alongada similar a um barbilhão; (IV) contato entre o processo posterior do parieto-supraoccipital e a placa nucal; (V) faixa escura cruzando transversalmente a órbita, formando uma mancha em forma de máscara; (VI) ausência de um padrão de coloração distinto ao longo da linha mediana do flanco; (VII) placas dorsolaterais do corpo apenas com manchas pequenas, irregulares, arredondadas ou alongadas verticalmente, marrom-escuras ou pretas; cor de fundo das placas tipicamente escura, mas não formando manchas pretas grandes e conspícuas; e (VIII) ausência de uma mancha escura relativamente grande e conspícua na porção anterior da nadadeira dorsal.

Palavras-chave: Corydoradinae, *Corydoras* sp. CW83, Jacareacanga, Taxonomia, Volta Grande do Xingu.

INTRODUCTION

The Callichthyidae are Neotropical armored catfishes that can be promptly distinguished from remaining Siluriformes by having two longitudinal series of dermal plates on flanks (Reis, 2003; Tencatt, 2022a). Currently, the family harbors more than 220 valid species, from which about 180 are included in *Corydoras* Lacépède, 1803 (Fricke *et al*., 2023), making it one of the most species-rich genera of Siluriformes (Tencatt *et al*., 2023). Despite the comprehensive studies aiming to elucidate the taxonomy (*e.g*., Eigenmann, Eigenmann, 1890; Ellis, 1913; Gosline, 1940; Nijssen, 1970; Nijssen, Isbrücker, 1967, 1980a, 1983, 1986) and phylogenetic relationships (*e.g*., Britto, 2003; Alexandrou *et al*., 2011) of the species within *Corydoras*, taxonomists just scratched the surface on these fields of knowledge (Britto *et al*., 2007; Tencatt, Ohara, 2016a).

Corydoras is widely distributed within cis-Andean South America, with more than half of its representatives occurring in the Amazon basin (Britto, 2003; Tencatt, Ohara, 2016b). One of the most iconic affluents of the rio Amazonas is the rio Xingu, with several new fish species being described in the last few years (*e.g*., Silva *et al*., 2020; Tencatt *et al*., 2020; Costa *et al*., 2021; Garavello *et al*., 2021; Lehmann, Reis, 2021; Oliveira *et al*., 2021; de Pinna, Dagosta, 2022; Neuhaus *et al*., 2022; Reis, Lehmann, 2022; Sabaj *et al*., 2022; Silva *et al*., 2022). Interestingly, a remarkably low number of *Corydoras* species are formally known to occur in the rio Xingu basin, with *C. benattii* Espíndola, Tencatt, Pupo, Villa-Verde & Britto, 2018 and *C. xinguensis* Nijssen, 1972 as the only described representatives. The number of putative undescribed species recognized by the fishkeeping hobby said to occur in the rio Xingu basin is also low, with only three morphotypes, *Corydoras* sp. C21, C87 and CW189 (see Tencatt, Evers (2016) for further information on the coding system in Corydoradinae), suggesting that the diversity of this genus in the rio Xingu basin is still poorly known.

Another remarkable subdrainage forming the Amazon basin is the rio Tapajós system, with nearly 1,000 described fish species (Jézéquel *et al*., 2020). Currently, nine *Corydoras* species are known to occur in this basin, namely: *C. apiaka* Espíndola, Spencer, Rocha & Britto, 2014, *C. benattii*, *C. bifasciatus* Nijssen, 1972, *C. hephaestus* Ohara, Tencatt & Britto, 2016, *C. ornatus* Nijssen & Isbrücker, 1976, *C. rikbaktsa* Lima & Britto, 2020, *C. hypnos* Tencatt, Ohara, Sousa & Britto, 2022, *C. thanatos* Tencatt, Ohara, Sousa & Britto, 2022 and *C. psamathos* Tencatt, Ohara, Sousa & Britto, 2022 (Dagosta, de Pinna, 2019; Lima, Britto, 2020; Tencatt *et al*., 2022a). Contrasting with the rio Xingu basin, the rio Tapajós basin currently has 27 coded species: C86, C133, C145, CW4, CW66, CW83, CW101, CW102, CW127, CW135, CW155, CW156, CW162, CW167, CW168, CW170, CW171, CW174, CW176, CW186, CW187, CW191, CW193, CW194, CW195, CW196, and CW203, which highlight the gap between the number of formally described species and the incoming of possible new species in the aquarium hobby, as discussed by Tencatt *et al*. (2022a).

As noted above, the only *Corydoras* species currently known from both rio Xingu and rio Tapajós basins is *C. benattii*. The analysis of *Corydoras* specimens from the rivers Bacajá and Bacajaí plus smaller tributaries of the rio Xingu basin draining the region of the Volta Grande do Xingu, revealed the presence of an undescribed new species of *Corydoras* fitting a coded species recorded from the rio Tapajós basin, *Corydoras* sp. CW83. During the description process, the first author was able to collect specimens from the rio Tapajós basin in the region of Jacareacanga fitting in both morphology and color pattern the populations from the rio Xingu basin and, consequently, *Corydoras* sp. CW83. Therefore, the aim of this study is to provide a formal description of this undescribed species of *Corydoras*.

MATERIAL AND METHODS

Measurements were obtained using digital calipers to the nearest tenth of millimeter. Morphometric and meristic data were taken following Tencatt *et al*. (2022b) and Reis (1997), respectively. Morphometrics are reported as proportions of standard length (SL) or head length (HL). Terminology of barbels follows Britto, Lima (2003). Regarding the orientation of the serrations on the posterior margins of the dorsal and pectoral spines, the terminology is according to Ballen, de Pinna (2021). For the osteological analysis, some specimens were cleared and stained (c&s) according to the protocol of Taylor, Van Dyke (1985). Osteological terminology was based on Reis (1998), except for the use of parieto-supraoccipital instead of supraoccipital (Arratia, Gayet, 1995), pterotic-extrascapular instead of pterotic-supracleithrum (Slobodian, Pastana, 2018), and scapulocoracoid instead of coracoid (Lundberg, 1970). Nomenclature of the latero-sensory canals and preopercular pores are according to Schaefer, Aquino (2000) and Schaefer (1988), respectively. The supra-preopercle *sensu* Huysentruyt, Adriaens (2005) was treated here as a part of the hyomandibula according to Vera-Alcaraz (2013). To determine the development degree of the anterior laminar expansion of infraorbital 1 in relation to the nasal capsule, the specimen was positioned to maintain the largest diameter of the nasal capsule horizontally. The width of frontal bone was obtained at the same point as the least interorbital width. Vertebral counts include only free

centra, with the compound caudal centrum (preural 1+ ural 1) counted as a single element. The last two dorsal-fin rays were counted as distinct elements. Pharyngeal teeth were counted in both sides of the branchial arches. Terminology regarding initial development follows Nakatani *et al*. (2001); the size of specimens in initial development is exceptionally expressed in total length (TL).

Specimens from the rio Tapajós basin were regarded as non-types due the presence of subtle morphological differences (presented in the Discussion section) in relation to the specimens from the rio Xingu basin. In the description, numbers in parentheses represent the total number of specimens with those counts. Numbers with an asterisk refer to the counts of the holotype. Institutional abbreviations follow Sabaj (2020), except for CITL, Coleção Ictiológica de Três Lagoas, Três Lagoas, Mato Grosso do Sul, Brazil. Political geography data of the type material is presented in the following order: country, state and municipality. The Extent of Occurrence of the new species was estimated through the software GeoCAT (Geospacial Conservation Assessment Tool; http://geocat.kew.org). The comparative material examined is the same as listed in Tencatt *et al*. (2023).

RESULTS

Corydoras caramater, new species

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(Figs. 1-13, 16; Tab. 1)

Holotype. MNRJ 54621, 49.3 mm SL, Brazil, Pará, Senador José Porfírio, rio Bacajaí, rio Xingu basin, 03°53'30"S 51°43'13"W, 11 Jul 2014, A. Gonçalves & D. Bastos.

Paratypes. All from Brazil, Pará, Senador José Porfírio, rio Xingu basin, except when noted. CITL 929, 5 of 6, 35.7–45.3 mm SL, 1 of 6 c&s, 45.3 mm SL, rio Bacajaí, 03°41'20"S 51°45'08"W, 12 Jul 2014, A. Gonçalves & D. Bastos. CPUFMT 8150, 2, 35.2–40.7 mm SL, rio Bacajaí, 03°48'47"S 51°41'07"W, 9 Jul 2014, A. Gonçalves & D. Bastos. INPA 60241, 3, 33.8–44.4 mm SL, rio Bacajaí, 03°49'02"S 51°41'04"W, 11 Jul 2014, A. Gonçalves & D. Bastos. MZUSP 129261, 4, 36.9–39.8 mm SL, rio Bacajaí, 03°39'22"S 51°45'40"W, 12 Jul 2014, A. Gonçalves & D. Bastos. LIA 148, 2, 39.9–44.0 mm SL, rio Bacajaí, 03°36'19"S 51°46'05"W, 16 Oct 2013, A. Gonçalves. LIA 299, 4, 30.6–36.5 mm SL, 1 c&s, 39.1 mm SL, rio Bacajaí, 03°53'39"S 51°43'28"W, 11 Jul 2014, A. Gonçalves & D. Bastos. LIA 370, 3, 34.6–40.5 mm SL, rio Bacajaí, 03°50'23"S 51°40'42"W, 11 Jul 2014, A. Gonçalves & D. Bastos. LIA 530, 4, 28.6–39.8 mm SL, rio Bacajaí, 03°41'56"S 51°44'23"W, 11 Jul 2014, A. Gonçalves & D. Bastos. LIA 672, 1, 27.2 mm SL, rio Bacajaí, 03°38'41"S 51°45'13"W, 12 Jul 2014, A. Gonçalves & D. Bastos. LIA 864, 1, 36.5 mm SL, Vitória do Xingu, igarapé tributary of the rio Xingu, 03°19'29"S 51°47'20"W, 6 Oct 2014, D. Bastos & R. Oliveira. LIA 893, 2, 33.8–43.5 mm SL, Vitória do Xingu, igarapé tributary of the rio Xingu, 03°15'57"S 51°43'50"W, 5 Oct 2014, D. Bastos & R. Oliveira. LIA 970, 2, 38.5–46.8 mm SL, Anapu, igarapé

tributary of the rio Bacajá, 03°40'18"S 51°29'13"W, 3 Oct 2014, D. Bastos & R. Oliveira. LIA 1073, 8, 34.3–43.0 mm SL, 2 c&s, 35.9–41.6 mm SL, Anapu, igarapé tributary of the rio Bacajá, 03°40'18"S 51°29'13"W, 3 Oct 2014, D. Bastos & R. Oliveira. LIA 1996, 29, 30.1–44.8 mm SL, Vitória do Xingu, igarapé tributary of the rio Xingu, 03°15'57"S 51°43'50"W, 26 Jul 2014, D. Bastos & A. Martins. LIA 2257, 1, 43.7 mm SL, Anapu, igarapé tributary of the rio Xingu, 03°05'12"S 51°38'04"W, 20 Jul 2014, D. Bastos & A. Martins. LIA 3393, 2, 37.5–50.8 mm SL, Anapu, igarapé tributary of the rio Xingu, 03°05'12"S 51°38'04"W, 1 Oct 2015, R. Oliveira. LIA 5416, 4, 39.9–46.4 mm SL, Anapu, igarapé tributary of the rio Xingu, 03°05'12"S 51°38'04"W, 10 Jan 2015, R. Oliveira. LIA 6511, 3, 36.9–41.3 mm SL, Anapu, igarapé tributary of the rio Xingu, 03°05'12"S 51°38'04"W, 26 Aug 2016, T. Bernardi and J. Arcanjo. LIA 8170, 1, 38.1 mm SL, Anapu, igarapé Mosquito, 03°41'11"S 51°28'28"W, 7 Aug 2021, A. Ribeiro & P. Rocha. NUP 24841, 2, 29.3–44.6 mm SL, collected with the holotype.

FIGURE 1 | *Corydoras caramater*, holotype, MNRJ 54621, 49.3 mm SL, Senador José Porfírio, Pará, Brazil, rio Bacajaí, rio Xingu basin.

FIGURE 2 | Two preserved specimens of *Corydoras caramater*, showing general color and morphological patterns in lateral view of (**A**) a paratype (LIA 8170, 38.1 mm SL), and (**B**) a non-type specimen from the rio Tapajós basin (CPUFMT 8149, 1, 49.9 mm SL).

Non-type specimens. All from Brazil, Pará, Jacareacanga, *ca.* 06°12'S 57°45'W, 3–11 Jul 2023. CPUMT 8148, 13 of 14, 19.9–45.1 mm SL, 1 c&s of 14, 44.1 mm SL, igarapé Limãozinho, M. A. Pinheiro, W. M. Ohara & L. F. C. Tencatt. CPUFMT 8149, 1, 49.9 mm SL, rio Pacu, local fishermen.

Diagnosis. *Corydoras caramater* can be distinguished from its congeners, except for the species within the lineage 1 *sensu* Alexandrou *et al.* (2011), by the presence of the following features: branch of the temporal sensory canal at sphenotic, which gives rise to the supraorbital canal, with two pores (*vs.* one pore); upper tooth plate of branchial arch with three or four series of teeth (*vs.* two series); and area at the corner of the mouth, ventral to the maxillary barbel, with a small fleshy flap (*vs.* fleshy flap absent); from the lineage 1 species, except for *C. amapaensis* Nijssen, 1972, *C. blochi* Nijssen, 1971, *C. cortesi* Castro, 1987, *C. desana* Lima & Sazima, 2017, *C. pastazensis* Weitzman, 1963, *C. saramaccensis* Nijssen, 1970, *C. septentrionalis* Gosline, 1940, *C. serratus* Sands, 1995, *C. solox* Nijssen & Isbrücker, 1983, and *C. simulatus* Weitzman & Nijssen, 1970, by having a dark brown or black patch transversally crossing the orbit, forming a mask-like blotch, which can be variably diffuse (*vs.* mask-like blotch absent); it differs from *C. cortesi*, *C. desana*, *C. pastazensis*, *C. septentrionalis*, and *C. simulatus* by the absence of a distinct color pattern along midline of flank (*vs.* midline of flank with moderate- to large-sized, conspicuous dark brown or black blotches in *C. desana*, *C. pastazensis*, *C. septentrionalis*, and *C. simulatus*; with a longitudinal dark brown or black stripe in *C.*

cortesi); from *C. amapaensis*, *C. serratus* and *C. solox*, it differs by having dorsolateral body plates only with small, irregular, rounded or vertically elongated dark brown or black blotches; ground color of plates typically dusky but not forming large, conspicuous black patches (*vs.* midventral portion of dorsolateral body plates on region between middle portion of dorsal fin and caudal-fin base typically with large, conspicuous dark brown or black longitudinally elongated blotch or stripe; dark stripe variably diffuse, in *C. amapaensis*; wide, dark brown or black longitudinal stripe from predorsal region to caudal-fin base or, alternatively, dorsolateral body plates around anterior portion of dorsal-fin base with dark brown or black patch in *C. serratus*; region between anterior portion of dorsal fin and caudal-fin base with wide, longitudinal dark brown or black stripe in *C. solox*); from *C. blochi* and *C. saramaccensis* by the absence of a relatively large, conspicuous dark patch on anterior portion of dorsal fin (*vs.* anterior portion of dorsal fin with a conspicuous concentration of dark brown or black chromatophores, forming a relatively large, conspicuous patch). Additionally, *Corydoras caramater* can be distinguished from *C. geoffroy* Lacépède, 1803, *C. amapaensis*, *C. septentrionalis*, and *C. solox* by having a triangular fleshy flap at the corner of mouth, ventrally to maxillary barbel, not forming an elongated barbel-like structure (*vs.* fleshy flap at corner of mouth elongated, forming a barbel-like structure).

Description. Morphometric data in Tab. 1. Head laterally compressed with acutely convex dorsal profile, roughly triangular in dorsal view. Snout well developed, conical; conspicuously pointed in some specimens. Head profile slightly concave from tip of snout to anterior nares; nearly straight in some specimens; ascending nearly straight or slightly convex from this point to dorsal-fin origin; region of frontal fontanel slightly concave in some specimens. Profile slightly convex along dorsal-fin base. Postdorsal-fin body profile slightly concave to adipose-fin spine, concave from this point to caudal-fin base. Ventral profile of body nearly straight from isthmus to pectoral girdle, and slightly convex from this point until pelvic girdle. Profile nearly straight or slightly convex from pelvic girdle to base of first anal-fin ray, ascending concave until caudal-fin base. Body roughly elliptical in cross section at pectoral girdle, gradually becoming more compressed toward caudal fin. Highest body depth at vertical through anterior origin of dorsal fin.

Eye rounded, located dorsolaterally on head. Orbit delimited anteriorly by lateral ethmoid, anterodorsally by frontal, posterodorsally by sphenotic, posteroventrally by infraorbital 2, and anteroventrally by infraorbital 1 (Figs. 3, 4A). Anterior and posterior nares close to each other, only separated by flap of skin. Anterior naris tubular. Posterior naris close to anterodorsal margin of orbit, separated from it by distance similar to naris diameter. Mouth small, subterminal, width similar to bony orbit diameter. Maxillary barbel typically well developed, slightly surpassing anteroventral limit of gill opening; ranging from poorly developed, distant from anteroventral limit of gill opening, to moderately developed, nearly reaching anteroventral limit of gill opening in some specimens; base of barbel with fleshy flap on its dorsolateral portion (Fig. 5). Outer mental barbel with similar size or slightly longer than maxillary barbel. Inner mental barbel fleshy, base of each counterpart slightly separated from each other. Area at mouth corner, ventral to maxillary barbel, with small, roughly triangular fleshy flap (Fig. 5). Small rounded papillae covering entire surface of all barbels, upper and lower lips, snout and isthmus.

TABLE 1 | Morphometric data of the holotype and 17 paratypes of *Corydoras caramater*. SD = Standard deviation.

	Holotype	Low–High	Mean±SD
Standard length (mm)	49.3	29.3–49.3	39.5±4.9
Percentage of standard length			
Depth of body	38.7	35.2–38.7	36.9±1.0
Predorsal distance	52.3	49.4–53.8	51.9±1.1
Prepelvic distance	49.1	48.2–51.8	50.0±0.9
Preanal distance	81.9	78.0–82.6	80.4±1.1
Preadipose distance	85.4	79.5–86.2	83.8±1.5
Length of dorsal spine	22.1	19.8–23.6	21.4±1.0
Length of pectoral spine	23.1	15.7–23.9	22.0±1.7
Length of adipose-fin spine	9.1	8.2–10.2	9.2±0.6
Depth of caudal peduncle	15.2	13.9–16.5	15.3±0.6
Length of dorsal-fin base	19.3	16.3–19.3	17.9±0.8
Dorsal to adipose distance	19.1	15.7–20.3	18.0±1.1
Maximum cleithral width	26.2	23.5–26.2	25.0±0.7
Head length	44.6	42.4–47.3	45.2±1.3
Length of maxillary barbel	15.6	11.6–20.1	17.8±2.0
Percentage of head length			
Head depth	80.5	73.7–80.5	76.0±1.9
Least interorbital distance	25.0	21.9–25.1	23.4±0.8
Horizontal orbit diameter	19.1	19.1–24.1	21.1±1.4
Snout length	46.8	44.2–49.2	46.7±1.5
Least internarial distance	13.2	10.5–13.6	11.9±0.9

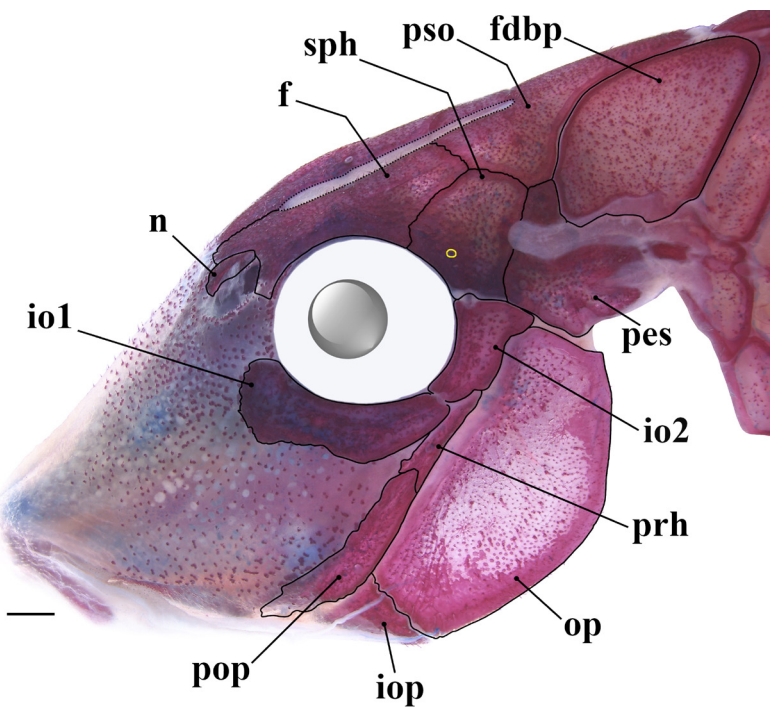

FIGURE 3 | Head osteological pattern in a c&s paratype of *Corydoras caramater* (LIA 1073, 41.6 mm SL), showing general morphology in lateral view. Abbreviations: f: frontal, fdbp: first dorsolateral body plate, io1–2: infraorbital 1 and 2, iop: interopercle, n: nasal, op: opercle, pes: pterotic-extrascapular, pop: preopercle, prh: posterodorsal ridge of hyomandibula, pso: parieto-supraoccipital, sph: sphenotic. Additional pore of the temporal sensory canal at sphenotic outlined in yellow. Scale bar = 1 mm.

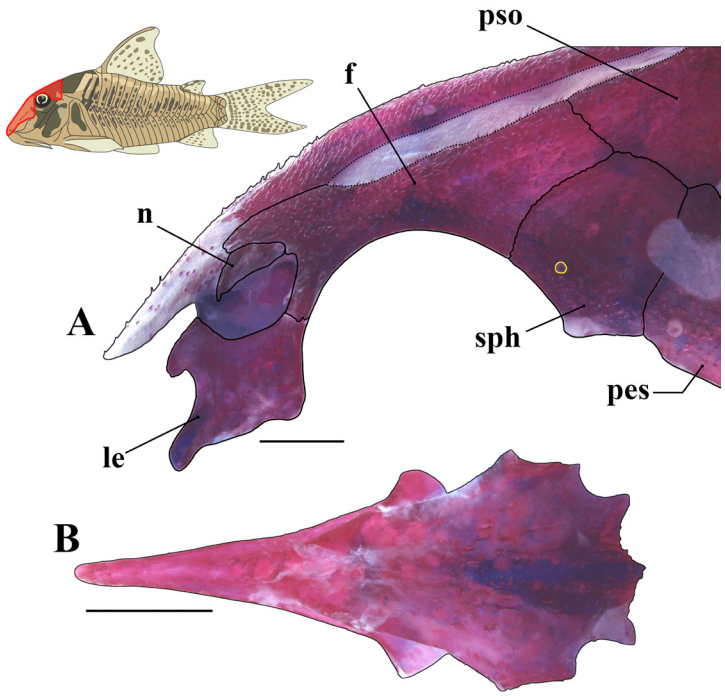

FIGURE 4 | Details on cranium osteological pattern in a c&s paratype of *Corydoras caramater* (LIA 1073, 35.9 mm SL), showing general morphology of (**A**) lateral ethmoid in lateral view, and of (**B**) mesethmoid in dorsal view. Abbreviations: f: frontal, le: lateral ethmoid, n: nasal, pes: pterotic-extrascapular, pso: parieto-supraoccipital, sph: sphenotic. Additional pore of the temporal sensory canal at sphenotic outlined in yellow. Area where the illustrated bones are located in fish's body marked in red in the miniature drawing of the new species. Scale bars = 1 mm.

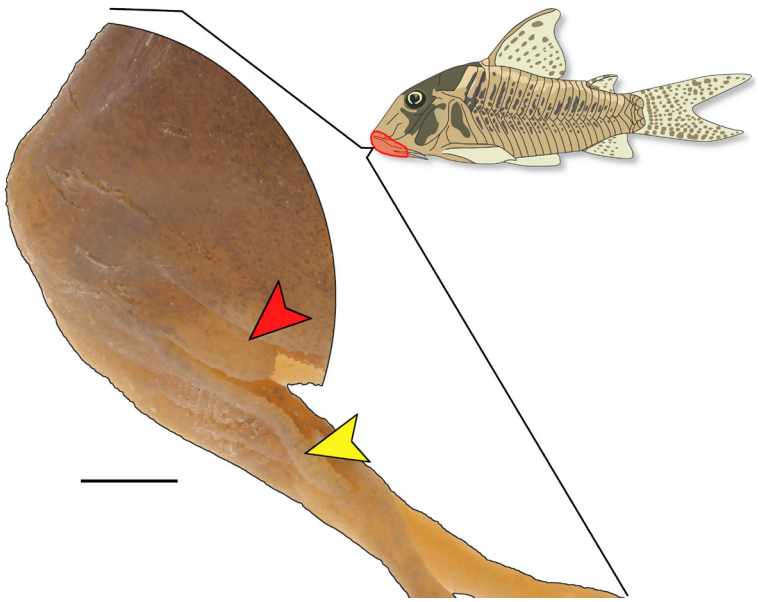

FIGURE 5 | Tip of snout in a paratype of *Corydoras caramater* (CITL 929, 45.3 mm SL), showing the area at corner of mouth in lateral view. Red arrow indicates the roughly triangular fleshy flap located between maxillary barbel and anteroventral portion of snout tip; yellow arrow indicates fleshy flap on dorsolateral portion of maxillary barbel base. Area where the illustrated structures are located in fish's body marked in red in the miniature drawing of the new species. Scale bar = 1 mm.

Mesethmoid long; anterior tip well developed, larger than 50% of bone length; posterior portion relatively narrow, entirely covered by thick layer of skin; posterior portion slightly narrower in specimen CPUMT 8148, 44.1 mm SL (Figs. 4B, 6). Nasal capsule typically delimited anterodorsally by mesethmoid, posterodorsally by frontal, and ventrally by lateral ethmoid; nasal capsule delimited dorsally by frontal and ventrally by lateral ethmoid in specimen CPUMT 8148, 44.1 mm SL. Nasal slender, laterally curved, inner margin with poorly- to moderately-developed laminar expansion, typically contacting only frontal; outer margin with poorly-developed laminar expansion, not contacting lateral ethmoid; strongly reduced laminar expansion in some specimens (Figs. 3, 4, 6). Lateral ethmoid deep in lateral view, conspicuously expanded anteriorly, with anterodorsal expansion contacting only mesethmoid, and anteroventral expansion connected to lateroventral process of mesethmoid; anterodorsal expansion contacting mesethmoid and frontal in CPUMT 8148, 44.1 mm SL (Fig. 3A). Frontal elongated, narrow, width less than half of entire length; anterior projection relatively short, size generally smaller than nasal length; moderately developed in some specimens, with size similar to nasal length; anterior projection long, with size larger than nasal length in specimen CPUMT 8148, 44.1 mm SL. Frontal fontanel large, slender, and somewhat ellipsoid; posterior tip extension clearly surpassing anterior margin of parieto-supraoccipital (Figs. 3, 6). Sphenotic somewhat trapezoid, contacting parieto-supraoccipital dorsally, pterotic-extrascapular posteriorly, second infraorbital posteroventrally and frontal anteriorly (Figs. 3, 6). Pterotic-extrascapular roughly pipe-shaped, with posterodorsal portion contacting first lateral-line ossicle, posteroventral margin contacting cleithrum, and anteroventral margin contacting

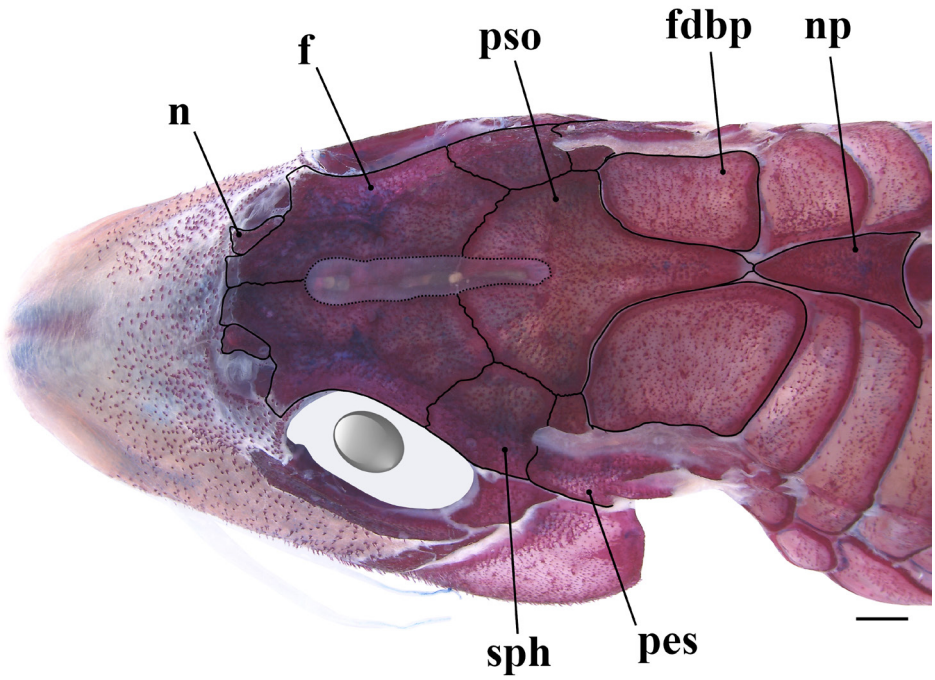

FIGURE 6 | Top of head and predorsal region of trunk of a c&s paratype of *Corydoras caramater* (LIA 1073, 41.6 mm SL) in dorsal view. Abbreviations: f: frontal, fdbp: first dorsolateral body plate, n: nasal, np: nuchal plate, pes: pterotic-extrascapular, pso: parieto-supraoccipital, sph: sphenotic. Scale bar = 1 mm.

opercle and infraorbital 2; posterodorsal expansion almost entirely covering lateral opening of swimbladder capsule, leaving slender area on its dorsal margin covered only by thick layer of skin (Figs. 3, 6). Parieto-supraoccipital wide, posterior process long and contacting nuchal plate; region of contact between posterior process and nuchal plate covered by thick layer of skin (Fig. 6).

Two laminar infraorbitals with minute odontodes. Infraorbital 1 large, ventral laminar expansion ranging from moderately to well developed; anterior portion with laminar expansion ranging from moderately developed, slightly surpassing middle portion of nasal capsule, to well-developed, reaching anterior margin of nasal capsule; inner laminar expansion strongly reduced (Figs. 3, 6, 7A). Infraorbital 2 small, widened dorsally, with posterior laminar expansion ranging from moderately to well developed; posteroventral margin contacting posterodorsal ridge of hyomandibula, posterodorsal edge contacting sphenotic and pterotic-extrascapular; inner laminar expansion strongly reduced (Figs. 3, 6, 7B). Posterodorsal ridge of hyomandibula close to its articulation with opercle slender, exposed, and bearing small odontodes (Figs. 3, 7C). Dorsal ridge of hyomandibula between pterotic-extrascapular and opercle entirely or almost entirely

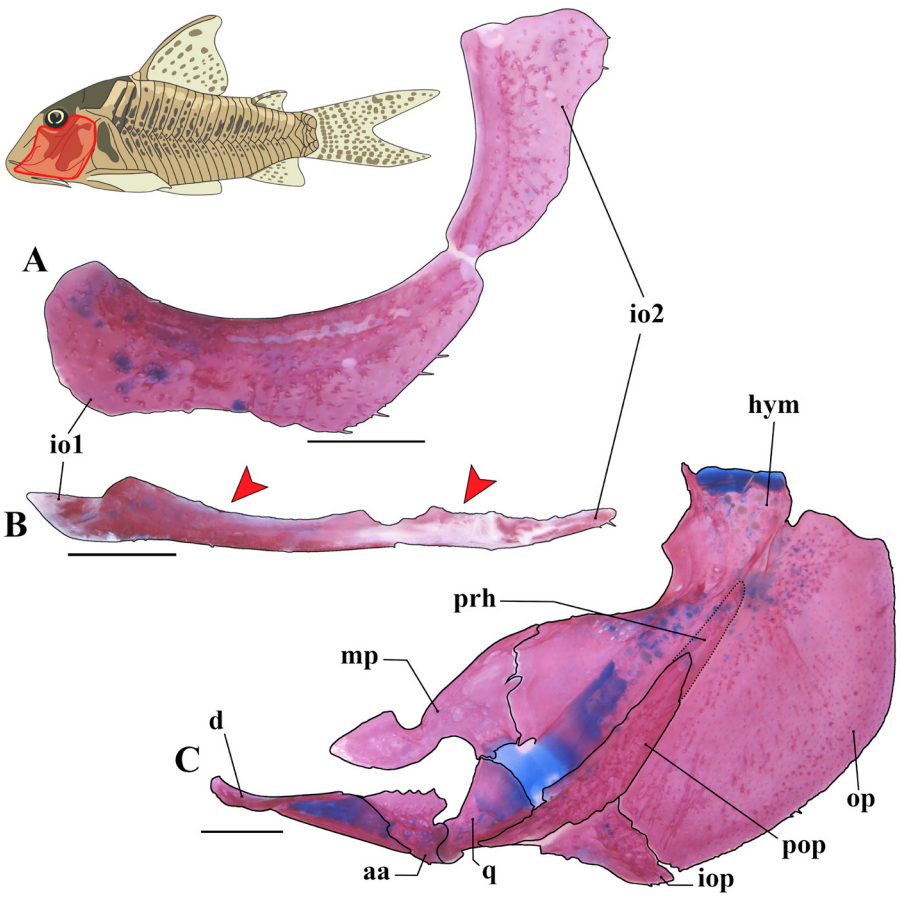

FIGURE 7 | Infraorbital series in lateral (**A**) and dorsal (**B**) views, and (**C**) suspensorium plus operculum in lateral view of a c&s paratype of *Corydoras caramater* (LIA 1073, 35.9 mm SL). Abbreviations: aa: angulo-articular, d: dentary, hym: hyomandibula, io1–2: infraorbital 1 and 2, iop: interopercle, mp: metapterygoid, op: opercle, pop: preopercle, prh: posterodorsal ridge of hyomandibula, q: quadrate. Red arrows indicate the inner laminar expansions of both infraorbitals. Area where the illustrated bones are located in fish's body marked in red in the miniature drawing of the new species. Scale bars = 1 mm.

covered by posterodorsal portion of infraorbital 2; entirely covered by thick layer of skin in some specimens. Interopercle partially covered by thick layer of skin, with posterior portion exposed and bearing odontodes; subtriangular, anterior projection moderately developed (Figs. 3, 7C). Preopercle elongated, relatively slender; minute odontodes on external surface (Figs. 3, 7C). Opercle dorsoventrally elongated, width slightly smaller than half of its entire length; free margin convex, posterodorsal portion with smoothly concave area in some specimens; without serrations and covered by small odontodes (Figs. 3, 7C).

Four branchiostegal rays decreasing in size posteriorly. Hypobranchial 1 deep, with mesial expansion poorly to well ossified; hypobranchial 2 somewhat triangular, tip ossified and directed towards anterior portion, posterior margin cartilaginous; ossified portion ranging from strongly reduced to poorly developed, with cartilaginous portion at least twice of its size in smaller specimens (LIA 299, 39.1 mm SL; LIA 1073, 35.9–41.6 mm SL) (Fig. 8A); ossified portion well developed in larger specimens (CPUMT 8148, 44.1 mm SL; CITL 929, 45.3 mm SL), around twice size of cartilaginous portion (Fig. 8C). Five ceratobranchials with expansions increasing posteriorly; ceratobranchial 1 with strongly reduced process on anterior margin of mesial portion; ceratobranchial 3 with continuous laminar expansion on postero-lateral margin; ceratobranchial 5 toothed

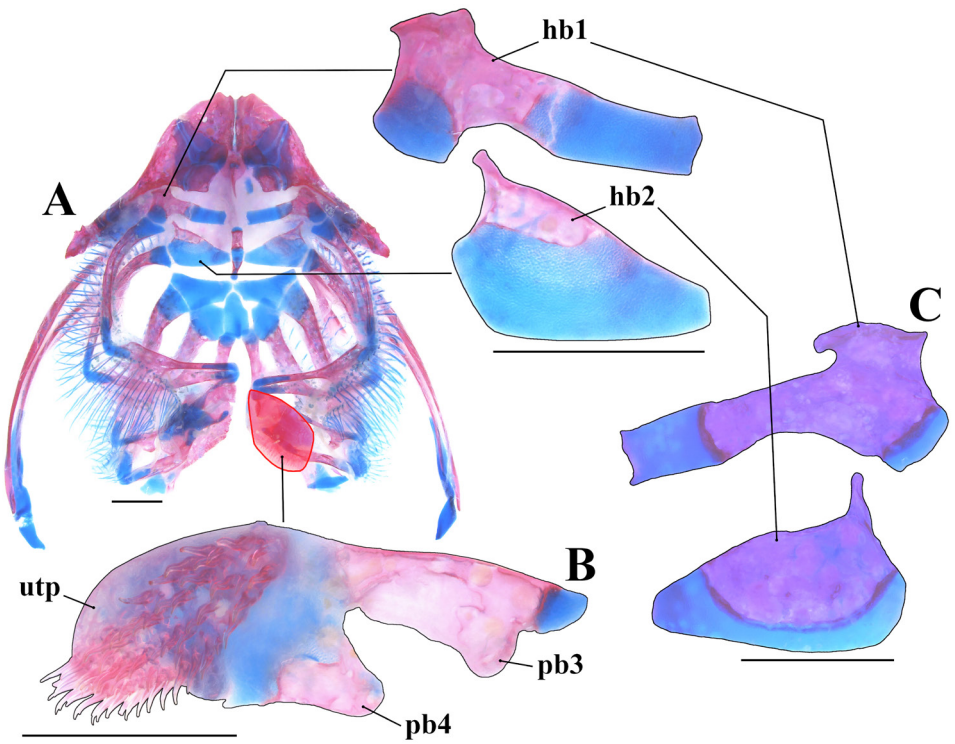

FIGURE 8 | Hyoid and branchial arches in (**A**) a c&s paratype of *Corydoras caramater* (LIA 1073, 35.9 mm SL), showing its general morphology in dorsal view, with the detail of hypobranchial (hb) 1 and 2, and of (**B**) upper tooth plate plus pharyngobranchials ((pb3 and 4) 3 and 4). General morphology in dorsal view of both hypobranchials (1 and 2) of another c&s paratype (CITL 929, 45.3 mm SL). Area highlighted in red in (**A**) indicating the position of upper tooth plate plus pharyngobranchials in the branchial basket. Scale bars = 1 mm.

on posterodorsal surface, with 28 to 31(4) teeth aligned in one row. Four epibranchials with similar size; epibranchial 2 slightly larger than others, with small pointed process on laminar expansion of posterior margin; epibranchial 3 with roughly triangular uncinate process on laminar expansion of posterior margin; process variably bent mesially. Two wide pharyngobranchials (3 and 4); pharyngobranchial 3 with roughly triangular laminar expansion on posterior margin; expansion typically notched. Upper tooth plate roughly oval, 46 to 60(4) teeth aligned in three or four rows on posteroventral surface; rows slightly apart from each other (Fig. 8B).

Lateral-line canal reaching cephalic laterosensory system through pterotic-extrascapular, branching twice before reaching sphenotic: pterotic branch, with single pore, preoperculomandibular branch conspicuously reduced, with single pore opening close to postotic main canal; postotic main canal widens just posterior to pterotic branch. Sensory canal continuing through pterotic-extrascapular, reaching sphenotic as temporal canal, which splits into two branches: one branch giving rise to infraorbital canal, other branch connecting to frontal through supraorbital canal, with one and two pores, respectively. Supraorbital canal branched, running through nasal bone. Epiphyseal branch relatively long; pore opening close to frontal fontanel. Nasal canal with three openings, first on posterior edge, second on posterolateral portion and typically fused with first pore, and third on anterior edge; second opening variably absent. Infraorbital canal running through entire infraorbital 2, extending to infraorbital 1 and opening into two or three pores. Preoperculomandibular branch giving rise to preoperculo-mandibular canal, which runs through entire preopercle with three openings, leading to pores 3, 4, and 5, respectively; pore 3 opening at posterodorsal ridge of hyomandibula in some specimens.

Dorsal fin subtriangular, located just posterior to second or third dorsolateral body plate. Dorsal-fin rays II,7(1), II,7,i(1), II,8*(16), posterior margin of dorsal-fin spine with four to 11 strongly reduced to poorly-developed serrations, perpendicularly directed or antrorse; serrations restricted to distal half of spine; small odontodes on anterior and lateral surfaces of spine (Fig. 9A). Nuchal plate well developed, almost entirely exposed, with minute odontodes. Spinelet short; spine well developed, with adpressed distal tip reaching or slightly surpassing posterior origin of dorsal-fin base. Pectoral fin roughly triangular, its origin just posterior to gill opening. Pectoral-fin rays I,9,i(2), I,10*(11), I,10,i(3), I,11(2), posterior margin of pectoral spine with 13 to 19 conical serrations along almost its entire length, absent around origin of spine; most serrations well developed and retrorse; serrations close to origin of spine conspicuously less developed; some serrations variably perpendicularly directed; small odontodes on anterior, dorsal and ventral surfaces of spine (Fig. 9B). Anteroventral portion of cleithrum exposed; posterolateral portion of scapulocoracoid moderately developed, exposed, with anterior portion slightly expanded anteriorly, not in contact with anteroventral portion of cleithrum. Opening of axillary gland *sensu* Kiehl *et al.* (2006) apparently reduced to narrow slit just posterior to pectoral-fin spine base.

Pelvic fin oblong, located just below second or third ventrolateral body plate, and at vertical through second or third dorsal-fin branched rays. Pelvic-fin rays i,5*(18). Anterior internal process of basipterygium well developed and conspicuously laterally expanded, with nearly vertically placed dorsal lamina; anterior external process laminar, well developed, slightly to moderately expanded posteriorly; dorsal ischiac process

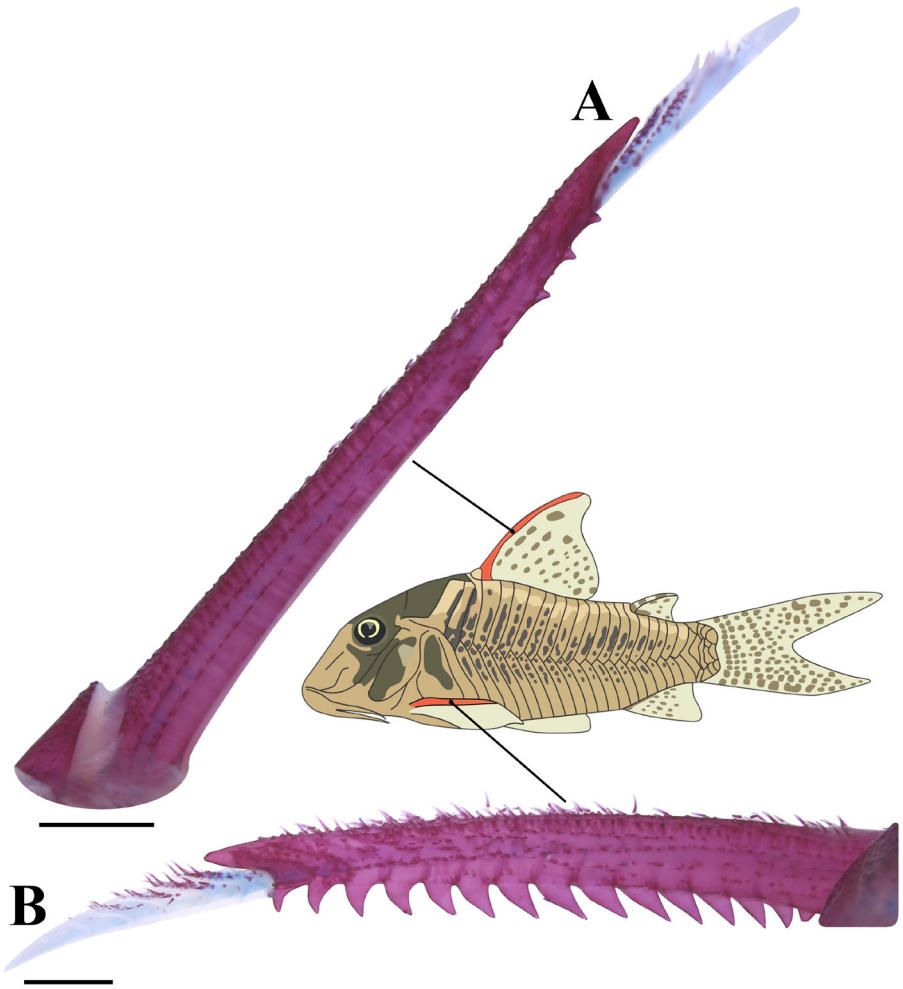

FIGURE 9 | Lateral view of (**A**) the dorsal-fin spine and dorsal view of (**B**) the left pectoral-fin spine in a c&s paratype of *Corydoras caramater* (LIA 1073, 41.6 mm SL), showing their serration patterns. Area where the illustrated bones are located in fish's body marked in red in the miniature drawing of the new species. Scale bars = 1 mm.

well developed, with anterior laminar expansion moderately expanded anteriorly, and posterior laminar expansion slightly to moderately expanded posteriorly; anterior and posterior laminar expansions of ischiac process roughly triangular or rounded; ventral ischiac process clearly smaller than dorsal process, roughly triangular, bent anteriorly (Fig. 10). Adipose fin roughly triangular, separated from base of last dorsal-fin ray by six or seven dorsolateral body plates. Anal fin subtriangular, located just posterior to 12th or 13th ventrolateral body plates, and at vertical through adipose-fin spine base or region of adipose-fin membrane. Anal-fin rays ii,5,i(3), ii,6*(15). Caudal fin bilobed, with dorsal lobe typically larger than ventral lobe; some specimens with dorsal lobe clearly smaller than ventral lobe, apparently by undergoing regeneration. Caudal-fin rays i,12,i*(18), with four or five dorsal and ventral procurrent rays; small cartilage between upper principal and procurrent caudal-fin rays (presumably opisthural cartilage (Monod, 1968; McDowall, 1999)) (Fig. 11).

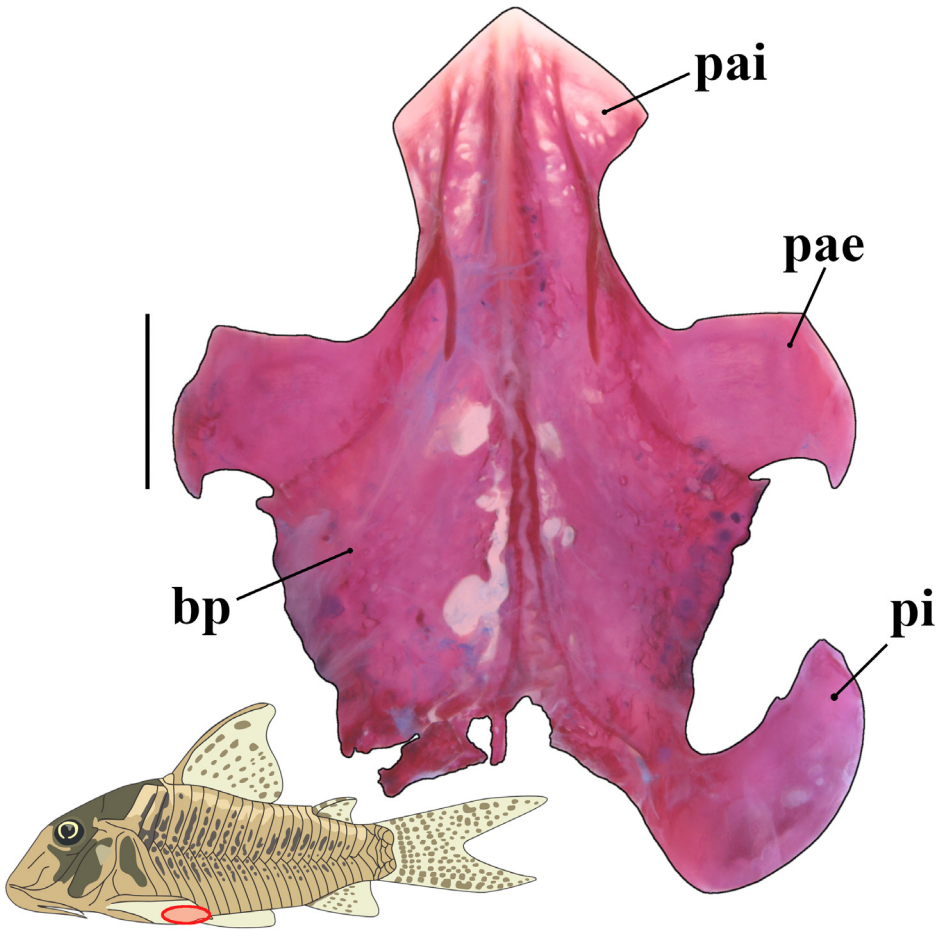

FIGURE 10 | Pelvic girdle in a c&s paratype of *Corydoras caramater* (LIA 1073, 35.9 mm SL). Abbreviations: bp: basipterygium, pae: anterior external process, pai: anterior internal process, pi: dorsal ischiac process. Area where the illustrated bones are located in fish's body marked in red in the miniature drawing of the new species. Left dorsal ischiac process damaged during dissection. Scale bar = 1 mm.

Four to six laterosensory canals on trunk; first ossicle tubular, second ossicle laminar, third, fourth, fifth and sixth lateral-line canals, if present, encased in third, fourth, fifth and sixth dorsolateral body plates, respectively. Body plates with minute odontodes scattered over exposed area, with conspicuous line of odontodes confined to posterior margins. Dorsolateral body plates 25(16), 26*(2). Ventrolateral body plates 22(16), 23*(2). Dorsolateral body plates along dorsal-fin base 6*(9), 7(9). Dorsolateral body plates between adipose- and caudal-fin 8(3), 9(14), 10*(1). Preadipose platelets 3(1), 4(15), 5*(2). Ventral surface of trunk between posteroventral margin of cleithrum and pelvic-fin origin laterally delimited by first and second ventrolateral body plates; ventral portion of first ventrolateral body plate ranging from slightly to moderately expanded anteriorly. Small platelets covering base of caudal-fin rays. Small platelets disposed dorsally and ventrally between junctions of lateral plates on posterior portion of caudal peduncle. Anterior margin of orbit, above region of junction between frontal and lateral ethmoid, ventral and anterodorsal margins of nasal capsule, lateral surface of

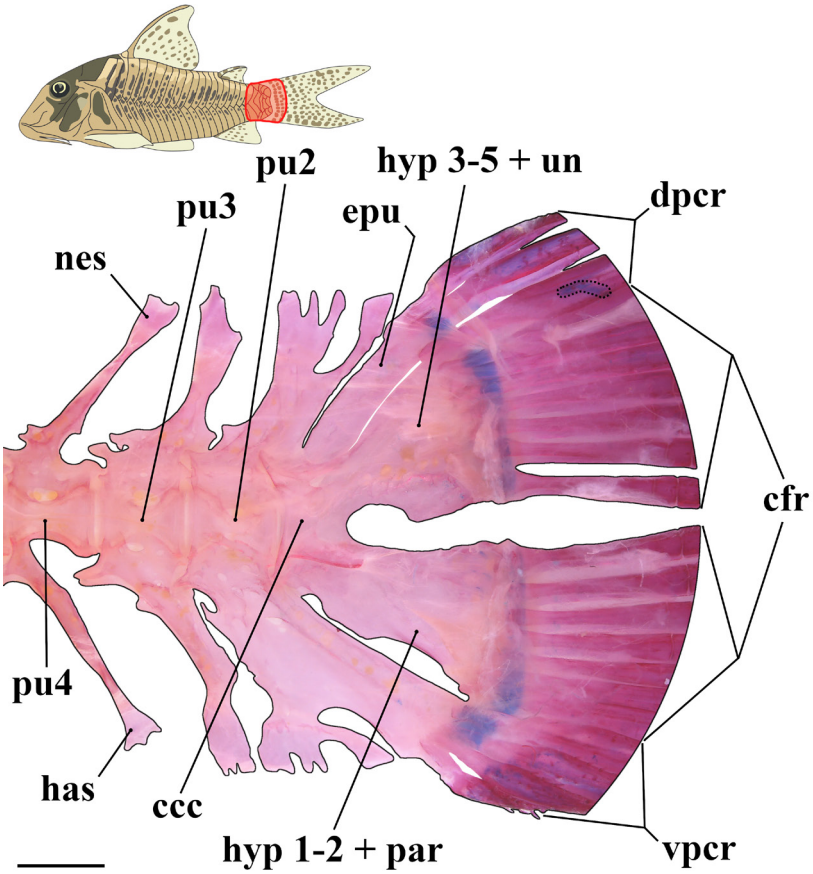

FIGURE 11 | General morphology of caudal skeleton in a c&s paratype of *Corydoras caramater* (LIA 1073, 41.6 mm SL), showing the small cartilage (black dotted line) between upper principal and procurrent caudal-fin rays. Abbreviations: ccc: compound caudal centrum, cfr: caudal-fin principal rays, dpcr: dorsal procurrent rays, epu: epural, has: haemal spine, hyp 1–5: hypurals 1 to 5, nes: neural spine, par: parhypural, pu 2–4: preural centra 2 to 4, un: uroneural, vpcr: ventral procurrent rays. Area where the illustrated bones are located in fish's body marked in red in the miniature drawing of the new species. Scale bar = 1 mm.

head below infraorbital 1, and lateral and dorsal portions of snout with numerous small platelets bearing odontodes; region around tip of snout typically devoid of platelets; region around nasal capsule and dorsal and lateral surfaces of snout with few platelets in specimen (CPUMT 8148, 44.1 mm SL). Ventral surface of head and trunk with small irregular platelets bearing odontodes; ventral surface of head variably lacking platelets on its anterior portion, with more numerous and concentrated platelets on its posterior portion, becoming gradually fewer and sparser towards posterior portion of trunk; mesial portion of ventral surface of trunk close pelvic fins and/or region around pectoral-fin origin with concentration of platelets in some specimens.

Vertebral count 22(1), 23(3); ribs 5(4); first pair conspicuously large, its middle portion closely connected to first ventrolateral body plate; its tip not connected to anterior external process of basipterygium. Parapophysis of complex vertebra well developed.

Coloration in alcohol. Overall color pattern of body in Figs. 1–2. Ground color of body pale- to brownish yellow or beige. Top of head dark brown. Dorsal and lateral surface of head, and lateral surface of cleithrum covered by dark brown or black chromatophores, not forming small blotches; elongated dark patch transversally crossing orbit, forming typical mask-like blotch, which is generally diffuse. Dorsolateral body plates with conspicuous concentration of dark brown or black chromatophores, forming small, irregular, rounded or vertically elongated dark brown or black blotches, which are roughly transversally aligned on plates; series of blotches on middle or posterior portion of dorsolateral body plates. Ventrolateral body plates with conspicuous concentration of dark brown or black chromatophores, forming small, irregular, rounded or vertically elongated dark brown or black blotches, which are roughly transversally aligned on plates; series of blotches typically restrict to dorsal half of ventrolateral body plates and placed on its middle portion. Blotches on lateral body plates more evident on anterior portion of trunk; posterior margin of body plates typically with dark brown or black chromatophores, forming thin dark lines along border of plates. Dorsal-fin with dark brown or black chromatophores, more concentrated on spine and rays, and typically forming small, diffuse dark blotches, which are roughly longitudinally or obliquely aligned. Pectoral and pelvic fins with dark brown or black chromatophores, not forming dark blotches; pelvic fin with scarce chromatophores in some specimens. Adipose fin with conspicuous concentrations of dark brown or black chromatophores, typically forming small, diffuse dark blotches, especially on its spine. Anal fin with dark brown or black chromatophores, which are more concentrated on rays, typically forming small, diffuse dark blotches roughly aligned transversally; blotches generally more evident on middle portion of fin. Caudal fin with conspicuous concentrations of dark brown or black chromatophores, mostly on rays, forming numerous, small, diffuse dark blotches, which are roughly aligned transversally; in some specimens, caudal-fin blotches slightly more evident than blotches in remaining fins.

Coloration in life. Similar to color pattern of preserved specimens, but with light yellowish orange ground color of body, especially on anterodorsal portion of trunk. Mask-like blotch variably more evident. Body covered by greenish yellow iridescent coloration (Figs. 12, 13).

Sexual dimorphism. As well-documented in Corydoradinae (see Britto, 2003; Nijssen, Isbrücker, 1980b; Spadella *et al*., 2017), male specimens of *C. caramater* present a genital papilla, which is somewhat tubular in shape.

Geographical distribution. *Corydoras caramater* is currently known from the basins of the rivers Bacajá and Bacajaí and other small tributaries of the right margin of the rio Xingu draining the region of the Volta Grande do Xingu, and also from tributaries of the rio Tapajós basin in the region of Jacareacanga, Pará State, Brazil (Fig. 14).

Ecological notes. In both rivers Xingu and Tapajós basins, *C. caramater* was captured from small streams to the main channel of smaller rivers (Fig. 15). In the igarapé Limãozinho (LFCT, pers. obs.), a tributary of the rio Tapajós basin, the new species was mostly observed in shallow sites (up to about 30 cm deep), with width ranging

FIGURE 12 | Uncatalogued aquarium specimens of *Corydoras caramater* from the rio Tapajós basin photographed alive, showing general color pattern and morphology of a male (**A**) and of a female (**B**) specimens. Photos by Hans Evers.

from 1 to 3 m, slow to moderate water current, and substrate mostly composed by fine sand and gravel, with areas of leaf litter and submerged branches/logs, as well as aquatic macrophytes. In this same site, the new species was observed shoaling together with two undescribed mimetic congeners (see Alexandrou *et al*. (2011) for a broader discussion on mimicry in Corydoradinae), *Corydoras* sp. CW101 (less abundant) and CW102 (most abundant), with the new species occurring in intermediate abundance when compared to both of them. Additionally, the new species was also captured with another undescribed congener in the igarapé Limãozinho, *Corydoras* sp. CW193. The new species was observed in the igarapé Sonrizal (Fig. 15C), rio Tapajós basin, in a similar habitat as described for the igarapé Limãozinho, except for its larger width (about 10 m) and depth (about 1.5 m). In the igarapé Sonrizal, the new species was observed in syntopy with the following congeners: *Corydoras* sp. C151, C152, CW66, CW174, and CW176. Similarly to the observed in the igarapé Limãozinho, *C. caramater* was found in syntopy with *Corydoras* sp. CW101 and CW102.

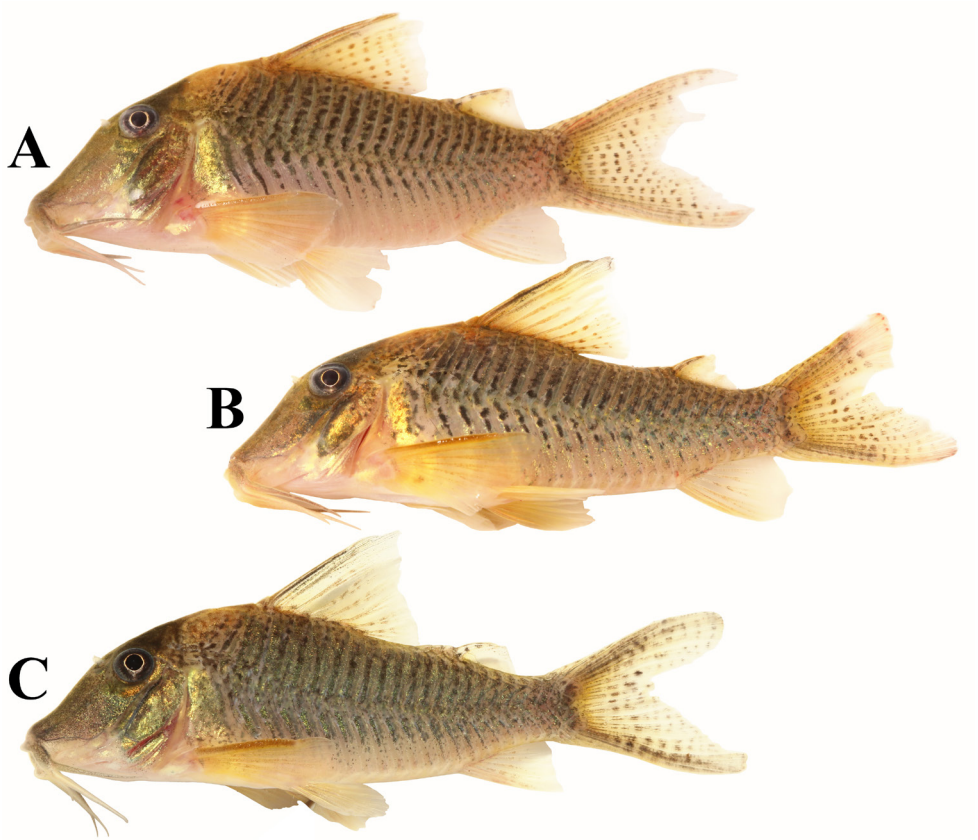

FIGURE 13 | Specimens of *Corydoras caramater* from the rio Tapajós basin photographed alive in lateral view, showing general color pattern and morphology of (**A**) an uncatalogued specimen from the rio Pacu with paler background color of body, (**B**) an uncatalogued specimen from igarapé Sonrisal with slightly darker background color of body, and (**C**) a non-type specimen (CPUFMT 8149, 1, 49.9 mm SL) from the rio Pacu with clearly darker background color of body. Photos by William Ohara.

Etymology. The specific epithet *caramater* is formed by the junction of two words derived from the Latin 'cara', which means dear, beloved, and 'mater', meaning mother. This is a small tribute to these strong women, who work hard and are still responsible, often alone, for tenderly raising their children. The name especially honors Miriam Tencatt, Jéssica Mendonça (mother and wife of LCFT, respectively), Ireide da Silva Pinto (mother of OLPC), Vanda Santos (*in memorian*), Roberta Murta-Fonseca (mother and wife of SAS, respectively), and Edina Melo de Sousa (mother of LMS), but extends to all caring mothers around the world. A noun in apposition.

Conservation status. *Corydoras caramater* is currently known from the Bacajá and Bacajaí river basins and other small tributaries of the right margin of the rio Xingu draining to Volta Grande do Xingu, plus tributaries of the rio Tapajós basin in the region of Jacareacanga, all in Pará, Brazil. Considering the type-locality region (rio Bacajaí), the negative effects to the ichthyofauna caused by the implementation of the Belo Monte hydroelectric complex must be closely monitored (see Keppeler *et al.*, 2022). Regarding the rio Tapajós basin population, the region of Jacareacanga is

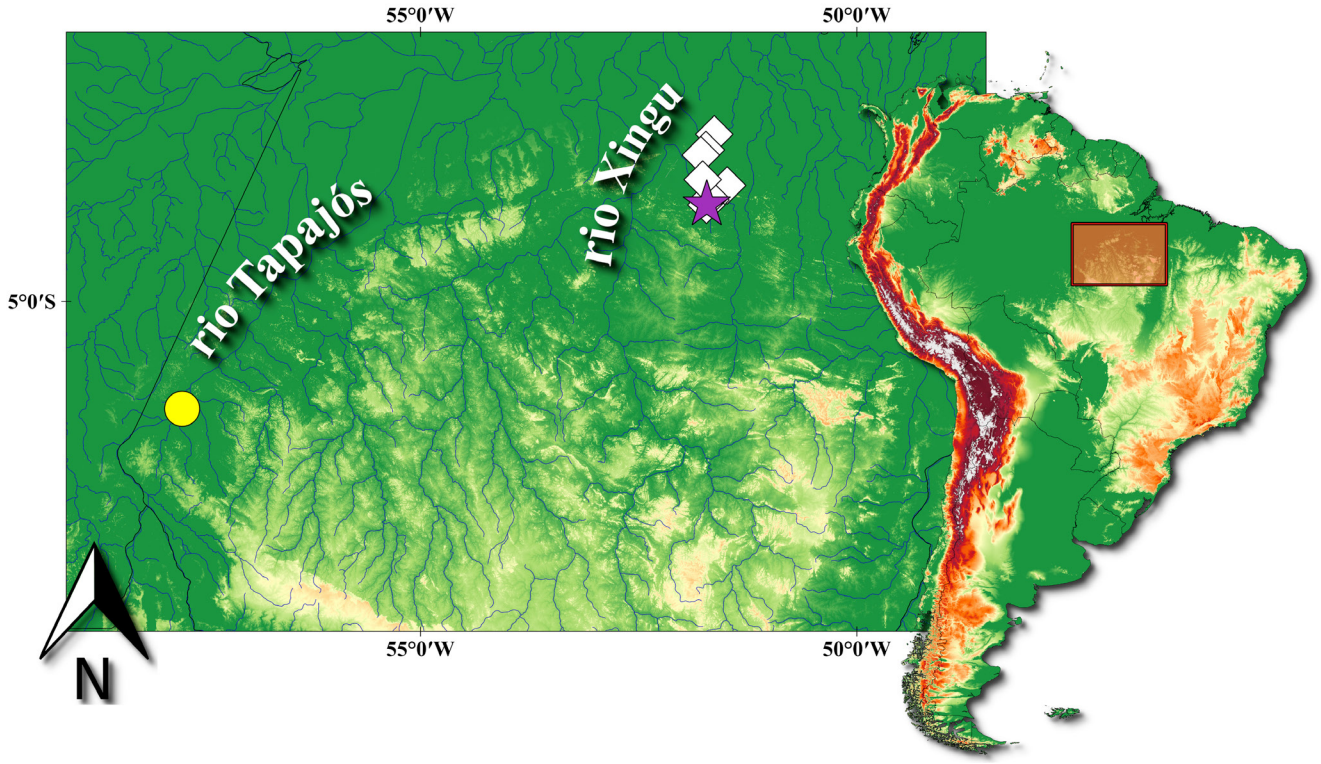

FIGURE 14 | Map showing the geographical distribution of *Corydoras caramater* in the rio Xingu basin (purple star: type-locality; white diamonds additional records), and in the rio Tapajós basin (yellow dot). Each symbol may represent more than one locality.

widely known by its intense gold-mining activities, which are often illegal, causing a wide range of negative impacts on nature (see de Bakker *et al*., 2021; Bandeira Junior, Carvalho, 2023). Although such negative impacts are known and worrying, there is no available evidence that they constitute a threat to the new species as a whole. Additionally, considering our findings, the Extent of Occurrence (EOO) was estimated at about 30.000 km^2, which represents a relatively large area. Therefore, according to the International Union for Conservation of Nature (IUCN) categories and criteria (IUCN Standards and Petitions Subcommittee, 2022), *Corydoras caramater* would be classified as Least Concern (LC).

Remarks. *Corydoras caramater* was bred under aquarium conditions by Hans Evers, who documented its ontogenetic development from 8.0 mm to 24.0 mm TL, showing general changes in external morphology and color pattern (Fig. 16). Specimen with 8.0 mm TL in early flexion stage (Fig. 16A) presents head slightly depressed, with short and conspicuously rounded snout; barbels relatively short and with well-developed papillae, which will gradually become less developed along individual's growth; eye large; median fin fold present, extending from post-cephalic region to genital opening; caudal-fin rays distinct, fin not detached from fin fold; dorsal, anal, pelvic and adipose fins not distinct; caudal-fin asymmetrical, dorsal portion distinctly longer than ventral; pectoral fin roughly rounded; body plates absent; dark brown or black chromatophores conspicuously more concentrated on anterior portion of trunk, forming a large dark patch; body covered by greenish yellow iridescent coloration.

FIGURE 15 | Collecting sites of *Corydoras caramater*, showing (**A**) the rio Bacajaí, (**B**) a small stream tributary of the rio Bacajá, both draining to the rio Xingu, and (**C**) the igarapé Sonrisal, a tributary of the rio Tapajós basin, all in Pará State, Brazil.

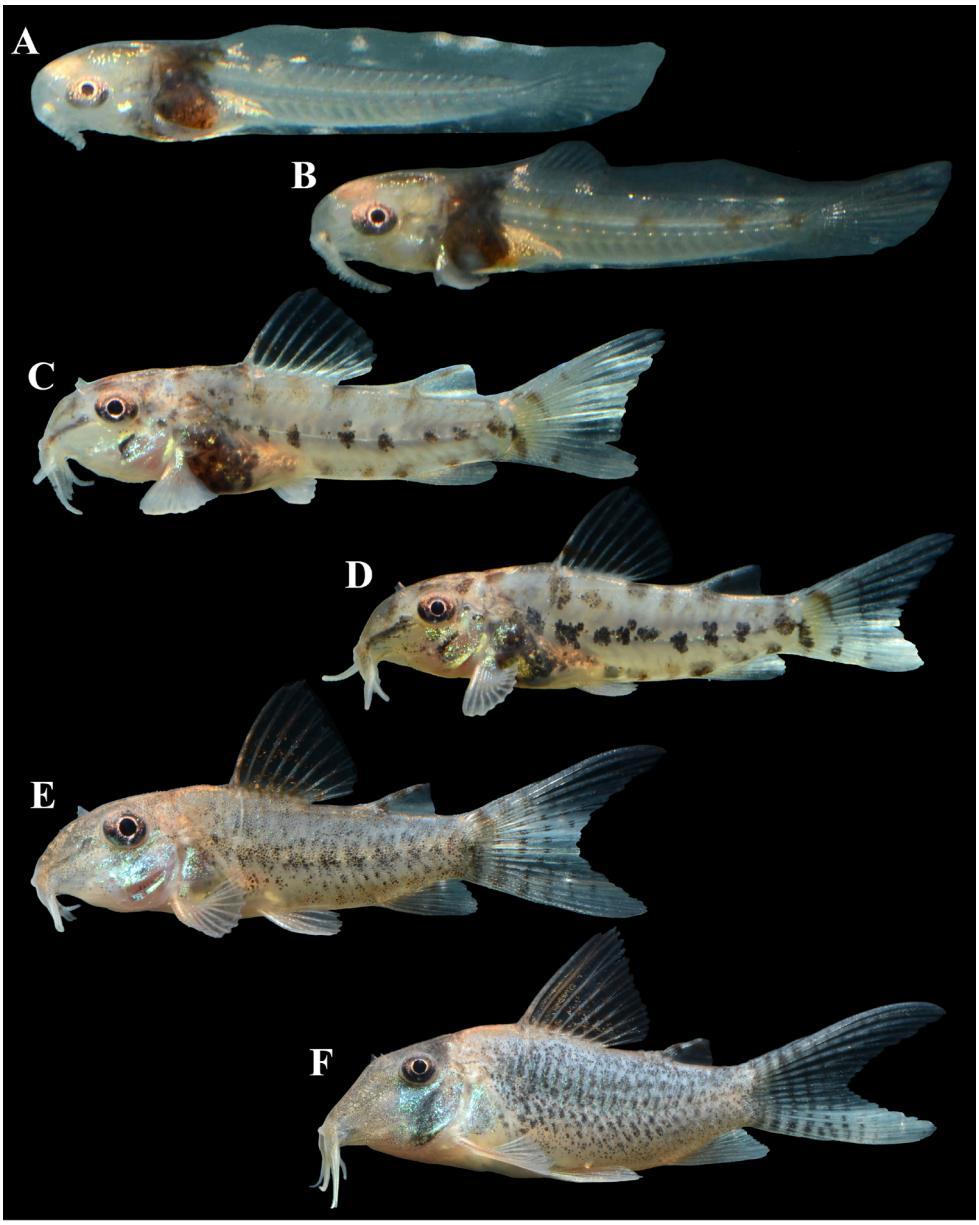

FIGURE 16 | Ontogenetic series of *Corydoras caramater* (bred under aquarium conditions) showing general changes in external morphology and color pattern in specimens with (**A**) 8.0 mm TL, (**B**) 10.0 mm TL; (**C**) 13.0 mm TL, (**D**) 16.0 mm TL, (**E**) 19.0 mm TL, and (**F**) 24.0 mm TL. Photos by Hans Evers.

Specimen with 10.0 mm TL in early post-flexion stage (Fig. 16B) displays slightly more pronounced snout, clearly more developed barbels, and reduction of median fold, with dorsal and caudal fins partially distinct; hypural plates visible by transparency; dorsal-fin rays distinct; pectoral fin slightly more developed; pelvic-fin fold partially detached; anal and adipose fins indistinct; slightly more pigmented body, with longitudinal series of diffuse dark blotches along midline of flank. Specimens with 13.0 and 16.0 mm TL, respectively, in early juvenile stage (Figs. 16C, D), showing the gradual development of snout, which becomes more pronounced and pointed along

individual's growth; complete absorption of median fold; pelvic, adipose and anal fins distinct; caudal fin bilobed, with ventral lobe clearly less developed than dorsal lobe; beginning of formation of lateral body plates; body gradually more pigmented, with continuous reduction of dark patch on anterior portion of trunk; roughly longitudinal series of diffuse dark blotches along dorsal and ventral portions of flanks; oblique dark stripe from anteroventral margin of orbit to upper lip lateral area, which is initially diffuse, turning more evident afterwards, and then gradually vanishing along individual's growth; caudal fin with somewhat transversal slender dark bars, gradually becoming more defined.

Juvenile specimen with 19.0 mm TL (Fig. 16E) with more developed lateral bony plates; caudal-fin ventral lobe well developed; body densely covered by dark brown or black chromatophores, forming small irregular dark blotches; longitudinal series of blotches on flanks diffuse. Color pattern and general external morphology of juvenile specimen with 24 mm TL (Fig. 16F) similar to fully growth specimens, but with slender body and slightly more diffuse coloration.

DISCUSSION

The analysis of smaller c&s paratypes (LIA 299, 1 c&s, 39.1 mm SL; LIA 1073, 2 c&s, 35.9–41.6 mm SL) revealed the presence of poorly ossified hypobranquial 1 and 2, an uncommon feature among Corydoradinae (Fig. 8A). Currently, a poorly ossified hypobranchial 2 is only reported for *C. difluviatilis* Britto & Castro, 2002, from which the new species differs by having the following features: (I) branch of the temporal sensory canal at sphenotic, which gives rise to the supraorbital canal, with two pores (*vs.* one pore); (II) upper tooth plate of branchial arch with three or four series of teeth (*vs.* two series); (III) corner of the mouth, ventral to the maxillary barbel, with a small fleshy flap (*vs.* fleshy flap absent); (IV) contact between posterior process of the parieto-supraoccipital and nuchal plate (*vs.* absence of contact between these structures); (V) a dark brown or black patch transversally crossing the orbit, forming a mask-like blotch, which can be variably diffuse (*vs.* mask-like blotch absent); and (VI) posterior margin of pectoral-fin spine with serrations along almost its entire length, absent around origin of spine (*vs.* serrations restricted to proximal half of the spine).

Despite the presence of such uncommon feature in smaller adult specimens (up to about 42.0 mm SL), larger adult specimens (CPUMT 8148, 1 c&s, 44.1 mm SL; CITL 929, 1 c&s, 45.3 mm SL) display both hypobranquial 1 and 2 with well-developed ossified portion (Fig. 8C), which is the most common condition within Corydoradinae (see Britto, 2003). Despite being ontogenetic variable, the presence of poorly-ossified hypobranquials in adult specimens was not observed in any other congener besides *C. difluviatilis*. Although rare and potentially informative at the phylogenetic level, this feature should be avoided for diagnostic purposes considering its variability. In any case, it is important to emphasize that such variability was only observed when comparing individuals from different sizes and not from different basins (*i.e.*, Xingu and Tapajós basins).

The available distribution records of *C. caramater* show a disjunct geographical occurrence, with relatively distant records from tributaries of the right bank of the rio Xingu and from tributaries of the rio Tapajós basin, region of Jacareacanga, Pará. Interestingly, the known geographic distribution of the new species resembles that of *C. benattii*, although more restricted. Similarly, other species were also described from both basins, such as: *Ancistrus luzia* Neuhaus, Britto, Birindelli & Sousa, 2022, *Archolaemus janeae* Vari, de Santana & Wosiacki, 2012, *Hopliancistrus munduruku* Oliveira, Zuanon, Rapp Py-Daniel, Birindelli & Sousa, 2021, *Leptodoras oyakawai* Birindelli, Sousa & Sabaj Pérez, 2008, *Moenkhausia pirauba* Zanata, Birindelli & Moreira, 2010, *Schizodon trivittatus* Garavello, Ramirez, Oliveira, Britski, Birindelli & Galetti, 2021, and *Spatuloricaria tuira* Fichberg, Oyakawa & de Pinna, 2014. Nevertheless, the absence of *C. caramater* in the tributaries of the left margin of the rio Xingu may be caused by the lack of a species-oriented sampling, and future efforts in the region should be made to address this issue.

Comparing the specimens from these two basins showed that both morphologic and color patterns are overall compatible (see Fig. 2), which made it impossible to provide a solid diagnosis separating the two populations into distinct species. The only putative diagnostic features raised herein are related to the morphology of the mesethmoid and lateral ethmoid, which slightly changes nasal capsule morphology, as pointed in the Description section (see exceptional cases related to specimen CPUMT 8148, 44.1 mm SL). Therefore, based only on the subtle differences in the morphology of these two bones, it seems premature to consider these two populations as two distinct species.

As aforementioned, specimens of *C. caramater* from the rio Tapajós basin were observed shoaling together with two congeners sharing similar color pattern, *Corydoras* sp. CW101 and CW102. Despite that, these species present clearly different morphological pattern. The presence of syntopic species sharing similar color pattern but having distinct morphology has been widely reported for *Corydoras* (*e.g.*, Nijssen, Isbrücker, 1980a,c; Britto, 2003; Britto *et al*., 2009; Alexandrou *et al*., 2011; Tencatt *et al*., 2013, 2019, 2021, 2022a; Lima, Sazima, 2017; Tencatt, Britto, 2016; Tencatt, Ohara, 2016a,b; Tencatt, Pavanelli, 2015). *Corydoras caramater* can be distinguished from both coded species by having the three main diagnostic features of the lineage 1 species *sensu* Alexandrou *et al*. (2011) (*i.e.*, features (I), (II) and (III) presented in the first paragraph of this section). The new species can be further distinguished from *Corydoras* sp. CW101 by lacking retrorse laminar serrations along posterior margin of dorsal-fin spine (*vs.* presence of retrorse laminar serrations); and from CW102 by having the posterior margin of the pectoral-fin spine with most serrations retrorse (*vs.* most serrations antrorse).

The molecular-based phylogenetic hypothesis of Alexandrou *et al*. (2011) recovered nine lineages of species within Corydoradinae, with lineage 2 composed by *Aspidoras* Ihering, 1907, lineage 3 by *Scleromystax* Günther, 1864, and lineages 1, 4, 5, 6, 7, 8 and 9 harboring the species within *Corydoras*. In the last decade, this work provided a valuable support for articles on systematics of the group, with the lineage system working as a "shortcut" in many species diagnoses (*e.g.*, Tencatt *et al*., 2013, 2016; 2019, 2020, 2021, 2022a, 2023; Tencatt, Pavanelli, 2015; Tencatt, Britto, 2016; Tencatt, Evers, 2016; Tencatt, Ohara, 2016a,b; Bono *et al*., 2019; Bentley *et al*., 2021). Regardless of the major advance provided by the work of Alexandrou *et al*. (2011), their results could not be entirely corroborated by morphological data, especially regarding lineages 6 and 9, which despite harboring typical short-snouted species with very similar morphological pattern (see Tencatt, Ohara (2016b)) were recovered as completely different clades.

Except for the lineages 6 and 9, morphological diagnoses for the remaining "*Corydoras*" lineages are currently available in literature (for lineage 1, see Tencatt *et al.* (2021); for 4 plus 5, see Bono *et al*. (2019); for 7, see Tencatt *et al*. (2023); and for 8, see Bentley *et al*. (2021)). Although *Corydoras* has been recovered as paraphyletic in all comprehensive phylogenetic hypothesis (*e.g*., Reis, 1998; Britto, 2003; Alexandrou *et al*., 2011; Marburguer *et al*., 2018), the classification of Corydoradinae remains unchanged since Britto's (2003) proposal, which may be partially explained by the difficulty in dealing with the fact that morphologically similar groups (lineages 6 and 9) were recovered as clearly distinct clades by Alexandrou *et al*. (2011).

Contrary to Alexandrou *et al*. (2011), the two most recent studies investigating the interrelations within Corydoradinae, the first one by Marburguer *et al*. (2018), with a nuclear-based phylogenetic hypothesis (pyRAD), and then by Dias (2022), with basis on Ultraconserved Elements, mostly corroborate the morphological data, showing that lineages 6 and 9 form a monophyletic group, the *Hoplisoma* Swainson, 1838 clade. Considering this, a broad study including both morphological and molecular data is being carried out by A. C. Dias and collaborators (working in progress), which will establish the monophyly of *Corydoras* and propose a new classification for the group. As previously mentioned, the simultaneous presence of some morphological features undoubtedly places *C. caramater* as a member of the *Corydoras* clade (= lineage 1 *sensu* Alexandrou *et al*. (2011)). Therefore, even with the publication of Dias and collaborators work, the new species will remain allocated in *Corydoras*.

ACKNOWLEDGMENTS

The Universidade Estadual de Mato Grosso do Sul, the Universidade Federal de Mato Grosso (UFMT), the Universidade Federal de Mato Grosso do Sul (UFMS) and the Universidade Federal do Pará (UFPA) provided logistical support. The authors are grateful to Anja Palandacic (NHM), Carlos Lucena and Margarete Lucena (MCP), Cláudio Oliveira (LBP), Clemency Fisher and Tony Parker (LIV), Edda Assel and Peter Bartsch (ZMB), Esther Dondorp (ZMA/RMNH), Mário de Pinna, Aléssio Datovo, and Osvaldo Oyakawa (MZUSP), Kris Murphy, Sandra Raredon, and Jeffrey Clayton (USNM), Mark Sabaj and Mariangeles Arce (ANSP), Alexandre Ribeiro (CPUFMT), James Maclaine and Oliver Crimmen (BMNH), and Otávio Froehlich (*in memoriam*) (ZUFMS), Olivier Pauwels and Terry Walschaerts (IRSNB), Patrice Pruvost, Zouhaira Gabsi, and Jonathan Pfliger (MNHN), Ralph Britz and Mario Richter (MTD F), and Raphael Covain (MHNG), for hosting museum visits and loaning of material. To Francisco Severo-Neto and Thomaz Sinani (ZUFMS-PIS), Carlos Lucena and Héctor Vera-Alcaraz (MCP), Cláudio Oliveira, Ricardo Britzke, Fábio Roxo, Bruno Melo, and Gabriel Silva (LBP), Claudio Zawadzki and Iago Penido (NUP), Olivier Pauwels (IRSNB), Willian Ohara, Vinícius Espíndola, Vinícius Reis, and Túlio Teixeira (MZUSP) for generously welcoming LFCT and/or SAS during museum visits. To Marcos Pinheiro and William Ohara for the invaluable support during the fieldwork in the rio Tapajós basin, Jacareacanga, Pará. To Hans Evers and William Ohara for sending and allowing the use of photos in life of *Corydoras caramater*. To Fernando Vaz-de-Mello plus Jorge Arias and Andressa Bach from the Laboratório de Scarabaeoidologia

(UFMT) for allowing the use and general support of the photomontage equipment Leica M205C (subproject EECBio UFMT/Finep #01.12.0359.00), respectively. Part of the material available was collected on the federal environmental licensing process associated with the Belo Monte hydroelectric complex (#02001.001848/2006–75) and was part of OLPC Master's Dissertation from Programa de Pós-Graduação em Biodiversidade e Conservação (PPGBC/UFPA). This study was financed in part by the Fundação Universidade Federal de Mato Grosso do Sul, UFMS/MEC, Brazil. We are thankful to Steven Grant for kindly reviewing the English language of this manuscript. A special thanks to the members of the fish keeping groups *Corydoras* World (United Kingdom/UK), Catfish Study Group (UK), Internationale Gemeinschaft Barben Salmler Schmerlen Welse e.V. (Germany), Potomac Valley Aquarium Society (United States of America/USA), Ohio Cichlid Association (USA), All Oddball Aquatics (USA) and Greater Pittsburgh Aquarium Society, Inc. (USA) for the invaluable support to LFCT.

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AUTHORS' CONTRIBUTION

Luiz Fernando Caserta Tencatt: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing-original draft, Writing-review and editing.

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Sérgio Alexandre dos Santos: Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing-original draft, Writing-review and editing.

Leandro Melo de Sousa: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing-original draft, Writing-review and editing.

ETHICAL STATEMENT

This study was mostly based on museum specimens, and no collecting permit was necessary regarding new species' type series; the non-type specimens were collected under the license #85671-1, granted to LFCT by the Sistema de Autorização e Informação em Biodiversidade (SISBIO).

COMPETING INTERESTS

The author declares no competing interests.

HOW TO CITE THIS ARTICLE

- **Tencatt LFC, Couto OLP, Santos SA, Sousa LM.** A new long-snouted *Corydoras* (Siluriformes: Callichthyidae) from the rio Xingu and rio Tapajós basins, Brazilian Amazon. Neotrop Ichthyol. 2024; 22(1):e230112. https://doi.org/10.1590/1982-0224-2023-0112

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