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A new masked *Corydoras* (Siluriformes: Callichthyidae) from the Itaya and Nanay river basins, Peruvian Amazon

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A new species of *Corydoras* is described from the Itaya and Nanay river basins, tributaries of the Río Amazonas in Peru. The new species can be distinguished from its congeners by the following features: (I) branch of the temporal sensory canal at sphenotic, which gives rise to the supraorbital canal, with two pores, (II) upper tooth plate of branchial arch with three series of teeth, (III) area at the corner of the mouth, ventral to the maxillary barbel, with a small, triangular fleshy flap, which may variably present a small prolongation at its posterior tip, forming a short barbel-like structure, (IV) a conspicuous dark brown or black patch transversally crossing the orbit, forming a mask-like blotch, (V) absence of a distinct color pattern along midline of flank, (VI) dorsolateral body plates only with small, irregular, rounded or vertically elongated dark brown or black blotches; ground color of plates typically light yellow or beige, (VII) absence of a relatively large, conspicuous dark blotch on anterior portion of dorsal fin, and (VIII) ossified portion of hypobranchial 2 ranging from moderately developed to well developed.

Keywords: Corydoradinae, *Corydoras* sp. C53, Iquitos, Mimicry, Taxonomy.

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Una nueva especie de *Corydoras* se describe de las cuencas de los Ríos Itaya y Nanay, tributarios del Río Amazonas en Perú. La nueva especie se puede distinguir de sus congéneres por las siguientes características: (I) rama del canal sensorial temporal en el esfenótico, que da origen al canal supraorbital, con dos poros, (II) placa dental superior del arco branquial con tres series de dientes, (III) área en la esquina de la boca, ventral a la barbilla maxilar, con una pequeña porción de tejido carnoso triangular, que puede presentar variaciones con una pequeña prolongación en su extremo posterior, formando una estructura semejante a una barbilla corta, (IV) una mancha conspicua de color marrón oscuro o negro que cruza transversalmente la órbita, formando una mancha con aspecto de máscara, (V) ausencia de un patrón de color distintivo a lo largo de la línea media del flanco, (VI) placas dorsolaterales del cuerpo solo con pequeñas manchas oscuras de color marrón oscuro o negro, irregulares, redondeadas o alargadas verticalmente; el color base de las placas típicamente es amarillo claro o beige, (VII) ausencia de una mancha oscura relativamente grande y conspicua en la porción anterior de la aleta dorsal, y (VIII) porción osificada del hipobranquial 2 que va desde moderadamente desarrollada hasta bien desarrollada.

Palabras clave: Corydoradinae, *Corydoras* sp. C53, Iquitos, Mimetismo, Taxonomía

INTRODUCTION

Callichthyidae is composed by small- to medium sized Neotropical armored catfishes characterized by the presence of two longitudinal series of dermal plates on the flanks (Reis, 1998, 2003). The family currently harbors more than 220 valid species, from which 185 are included in *Corydoras* Lacépède, 1803, making it one of the most species-rich genera of Siluriformes (Tencatt *et al*., 2022a, 2023a,b, 2024; Fricke *et al*., 2024). Several 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; Marburger *et al*., 2018) of *Corydoras* have been published since the 19th century. Despite that, large knowledge gaps in both fields still remain (Britto *et al*., 2007; Tencatt, Ohara, 2016a).

Corydoras is widely distributed within cis-Andean South America, having more than half of its representatives occurring in the Río Amazonas basin (Britto, 2003; Tencatt, Ohara, 2016b). In the Loreto region, Peruvian Amazon, 33 species of *Corydoras* have been currently recorded, representing 18% of the total known species of this genus (Meza-Vargas *et al*., 2021). The Río Nanay alone, a tributary of the Río Amazonas basin in Loreto, currently harbors 12 valid species of *Corydoras*: *C. agassizii* Steindachner, 1876, *C. ambiacus* Cope, 1872, *C. atropersonatus* Weitzman & Nijssen, 1970, *C. elegans* Steindachner, 1876, *C. leucomelas* Eigenmann & Allen, 1942, *C. loretoensis* Nijssen & Isbrücker, 1986, *C. napoensis* Nijssen & Isbrücker, 1986, *C. pygmaeus* Knaack, 1966, *C. rabauti* LaMonte, 1941, *C. reticulatus* Fraser-Brunner, 1938, *C. sychri* Weitzman, 1960,

and *C. trilineatus* Cope, 1872 (see Nijssen, Isbrücker, 1986). Additionally, five putative undescribed species coded by the aquarium trade (see Evers (1993) and Tencatt, Evers (2016) for more details on both "C" and "CW" code systems) are known to occur in the Río Nanay basin: *Corydoras* sp. C53, C96, C97, C123, and CW78.

Recently, collections were made in the tributaries crossing the Iquitos-Nauta Road, including samplings in tributaries of the Ríos Itaya and Nanay. These environments are currently experiencing impacts from deforestation, introduction of exotic species, and contamination from solid waste, which are threatening the diversity of fish found there (JC, MRT, pers. obs.). The collection in these fragmented habitats resulted in the capture of *Corydoras* specimens fitting both morphological and color patterns of *Corydoras* sp. C53. The analysis of such material allowed us to confirm that this species is indeed undescribed, which is formally described herein.

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 percent 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). Additionally, the ischiac process of the basipterygium is further divided into a dorsal and a ventral process following Huysentruyt, Adriaens (2005). Nomenclature of the laterosensory 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.

In the diagnosis, the species within lineage 1 *sensu* Alexandrou *et al.* (2011) refers to the clade harboring *Corydoras geoffroy* Lacépède, 1803 and its closest relatives; even though not included in their phylogenetic hypothesis, a species was herein considered as a member of the lineage 1 by having the following features: (I) branch of the temporal sensory canal at sphenotic, which gives rise to the supraorbital canal, with two pores, (II) upper tooth plate of branchial arch with three or four series of teeth, and (III) area at the corner of the mouth, ventral to the maxillary barbel, with a fleshy flap or a short barbel-

like structure. 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. Comparative data of *Corydoras cortesi* Castro, 1987, *C. saramaccensis* Nijssen, 1970, *C. serratus* Sands, 1995, and *C. solox* Nijssen & Isbrücker, 1983 were obtained from their original descriptions and/or high-resolution photographs of type specimens available from Morris *et al.* (2006). Institutional abbreviations follow Sabaj (2020). The comparative material examined can be found in Tencatt *et al.* (2023a,b, 2024).

For the characterization of the evaluated aquatic environments, a multiparameter equipment from HANNA, model HI98194, was used, with which physicochemical information of the water was collected during daytime hours.

The collection of this species is part of the project "Assessment of fish diversity in streams along the Iquitos-Nauta Road axis, Loreto, Peru" (#AOI00005300065), within the thematic axis of Species Conservation and Genetic Diversity. The thematic area is Biology and Ecology, and the research line is: 1) Taxonomy and systematics of cryptic, new, and unresolved species, and 2) Inventories of biological diversity in priority and poorly assessed areas.

RESULTS

Corydoras iiap, new species

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(Figs. 1–10; Tab. 1)

Holotype. CIIAP 3906, 55.2. mm SL, Peru, Loreto Region, Maynas Province, San Juan Bautista District, Iquitos-Nauta road km 26.4, Quebrada Paujil, lower Río Nanay basin, upper Río Amazonas basin, 03°57'49"S 73°25'02"W, 22 Mar 2023, M. Ruiz-Tafur, E. Agurto & J. Chuctaya.

Paratypes. All from Peru, Loreto Region, Maynas Province, San Juan Bautista District. **Río Nanay basin.** CIIAP 2649, 14, 15.1–52.4 mm SL; MNRJ 55393, 5 of 7, 28.0–50.4 mm SL, 2 c&s of 7, 41.5–50.4 mm SL, same data as holotype. CIIAP 3585, 3, 19.3–54.2 mm SL, Quebrada Santa Cruz, 03°52'56"S 73°27'12"W, 20 Apr 2023, M. Ruiz-Tafur & J. Chuctaya. **Río Itaya basin.** CIIAP 2706, 2, 48.9–53.2 mm SL, Quebrada Tocon, 04°05'00"S 73°26'54"W, 30 May 2023, M. Ruiz-Tafur, E. Agurto & J. Chuctaya. CIIAP 2737, 6, 37.1–59.8 mm SL, Quebrada Pintuyacu, 04°05'58"S, 73°27'18"W, 31 May 2023, M. Ruiz-Tafur, E. Agurto & J. Chuctaya. CIIAP 2760, 3, 26.5–49.6 mm SL, Quebrada Lindero, 04°09'03"S 73°28'25"W, 1 Jun 2023, M. Ruiz-Tafur, E. Agurto & J. Chuctaya. CIIAP 2794, 3, 31.5–54.6 mm SL, Quebrada Habanillo, 04°11'34"S 73°28'34"W, 1 Jun 2023, M. Ruiz-Tafur, E. Agurto & J. Chuctaya. CIIAP 2817, 1, 23.5 mm SL, Quebrada Habana, 04°12'09"S 73°28'45"W, 1 Jun 2023, M. Ruiz-Tafur, E. Agurto & J. Chuctaya. CIIAP 2913, 2, 33.3–55.2 mm SL, Quebrada San Pablo, 04°15'33"S 73°30'10"W, 21 Jun 2023, M. Ruiz-Tafur, E. Agurto & J. Chuctaya.

FIGURE 1 | *Corydoras iiap*, holotype, CIIAP 3906, 55.2 mm SL, San Juan Bautista District, Maynas Province, Loreto Region, Peru, Quebrada Paujil, Iquitos-Nauta Road, km 26.4, lower Río Nanay basin, upper Río Amazonas basin.

Diagnosis. *Corydoras iiap* 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 series of teeth (*vs.* two series); and area at the corner of the mouth, ventral to the maxillary barbel, with a small, triangular fleshy flap, which may variably present a small prolongation at its posterior tip, forming a short barbel-like structure (*vs.*

fleshy flap absent); from the lineage 1 species, except for *C. amapaensis* Nijssen, 1972, *C. blochi* Nijssen, 1971, *C. caramater* Tencatt, Couto, Santos & Sousa, 2024, *C. cortesi*, *C. desana* Lima & Sazima, 2017, *C. pastazensis* Weitzman, 1963, *C. saramaccensis*, *C. septentrionalis* Gosline, 1940, *C. serratus*, *C. solox*, and *C. simulatus* Weitzman & Nijssen, 1970, by having a conspicuous dark brown or black patch transversally crossing the orbit, forming a mask-like blotch (*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 light yellow or beige (*vs.* 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 in *C. amapaensis*; wide, dark brown or black longitudinal stripe from predorsal region to caudal-fin base 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); from *C. caramater* by having dorso- and ventrolateral body plates with pale yellow or beige background coloration, with dark blotches on flanks conspicuously standing out from the ground color of plates (*vs.* lateral body plates, especially of the dorsolateral series, with conspicuous concentration of dark brown or black chromatophores, with dark blotches on flanks slightly darker than ground color of plates), a conspicuous mask-like blotch (*vs.* mask-like blotch typically diffuse), and by the presence of ossified portion of hypobranchial 2 ranging from moderately developed, with size similar to cartilaginous portion, to well developed, around twice size of cartilaginous portion, even in smaller specimens with up to about 42.0 mm SL (*vs.* ossified portion of hypobranchial 2 ranging from strongly reduced to poorly developed, with cartilaginous portion at least twice of its size in specimens with up to about 42.0 mm SL; ossified portion well developed, around twice size the cartilaginous portion, present only in larger specimens with at least about 44.0 mm SL).

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 to slightly convex from that 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 to 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.

TABLE 1 | Morphometric data of the holotype and 25 paratypes of *Corydoras iiap*. SD = Standard deviation.

	Holotype	Low–High	Mean±SD
Standard length (mm)	55.2	23.5–59.8	43.9
Percent of standard length			
Depth of body	36.9	33.5–39.8	36.9±1.5
Predorsal distance	51.1	50.5–55.8	52.7±1.5
Prepelvic distance	48.9	46.8–53.1	49.0±1.5
Preanal distance	78.0	76.3–82.2	78.8±1.4
Preadipose distance	81.3	77.6–84.7	82.7±1.6
Length of dorsal spine	27.0	18.7–27.0	21.9±2.0
Length of pectoral spine	26.0	15.5–26.0	21.1±2.3
Length of adipose-fin spine	9.1	7.3–13.3	10.6±1.6
Depth of caudal peduncle	13.5	13.5–16.8	15.3±0.9
Length of dorsal-fin base	19.3	18.7–23.2	21.1±1.2
Dorsal to adipose distance	19.5	14.2–20.1	16.9±1.8
Maximum cleithral width	23.8	17.6–26.8	23.4±2.0
Length of maxillary barbel	18.4	12.7–19.2	16.1±2.1
Head length	43.6	43.6–49.2	45.4±1.6
Percent of head length			
Head depth	75.1	67.3–80.6	75.6±3.3
Least interorbital distance	20.7	17.3–26.8	20.9±2.6
Horizontal orbit diameter	16.8	14.5–23.6	17.2±2.3
Snout length	53.2	42.2–53.2	50.0±2.4
Least internarial distance	10.7	9.0–14.6	11.3±1.6

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. 2A, 3). 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; moderately developed, nearly reaching anteroventral limit of gill opening in some specimens; base of barbel with fleshy flap on its dorsolateral portion. 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; posterior tip of fleshy flap variably with small prolongation, forming short barbel-like structure. Small rounded papillae covering entire surface of all barbels, upper and lower lips, snout and isthmus.

Mesethmoid long; anterior tip well developed, larger than 50% of bone length; posterior portion relatively narrow, entirely covered by thick layer of skin (Figs. 2B, 3). Upper and lower jaws edentulous; premaxilla overall funnel-like shaped, with anteroventral surface roughly horizontally rectangular in frontal view; anteroventral margin irregular; posterodorsal portion with conspicuous pointed process, mesially set in frontal view

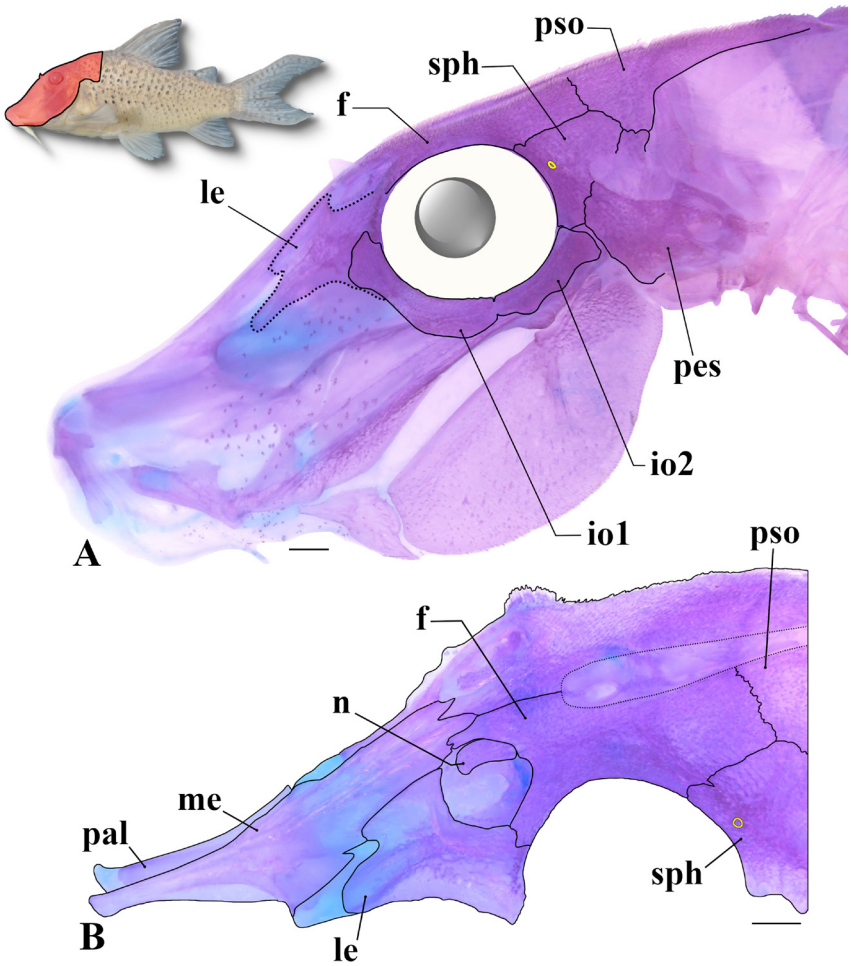

FIGURE 2 | Head osteological pattern in c&s paratype of *Corydoras iiap*, MNRJ 55393, 50.4 mm SL, showing general morphology in lateral view (**A**), with the detail of the nasal capsule and lateral ethmoid in dorsolateral perspective (**B**). Abbreviations: f: frontal, io1–2: infraorbital 1 and 2, le: lateral ethmoid, pal: palatine, 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 photo of a paratype (CIIAP 2913, 55.2 mm SL). Scale bars = 1 mm.

(Fig. 3B); maxilla elongated, relatively slender and roughly hatchet shaped in frontal view, its proximal half with roughly trapezoid laminar process on posterolateral portion (Fig. 3); dentary relatively slender, with rounded to roughly triangular or trapezoid expansion on its anteroventral portion, in ventrolateral perspective, perpendicularly directed or smoothly bent anteriorly; very small process on its posterodorsal portion; process more evident, pointed and bent posteriorly in juvenile c&s specimen (MNRJ 55393, 41.5 mm SL); anguloarticular relatively deep posteriorly, with roughly triangular dorsal laminar expansion, its posterodorsal margin typically irregular; dorsal laminar expansion bent posteriorly; posteroventral portion with roughly triangular process, in lateral view, bent posteriorly (Fig. 4C). Palatine longitudinally elongated, slender and with well-developed posterolateral process; roughly triangular dorsolateral longitudinal laminar expansion, gradually increasing in depth posteriorly (Fig. 3A).

Nasal capsule delimited anterodorsally by mesethmoid, posterodorsally by frontal, and ventrally by lateral ethmoid (Figs. 2B, 3). Nasal slender, laterally curved, inner margin with poorly- to moderately-developed laminar expansion, contacting only frontal; outer margin with strongly reduced to poorly-developed laminar expansion, not contacting lateral ethmoid (Figs. 2B, 3). Lateral ethmoid deep in lateral view, conspicuously expanded anteriorly, with anterodorsal expansion contacting only mesethmoid, and anteroventral expansion connected to lateroventral process of mesethmoid (Figs. 2, 3). Frontal elongated, narrow, width less than half of entire length; anterior projection ranging from moderately developed, with size similar to nasal length, to long, with size larger than nasal length in specimen (Figs. 2B, 3). Frontal fontanel large, slender, and somewhat ellipsoid; posterior tip extension clearly surpassing anterior margin of parieto-supraoccipital (Figs. 2B, 3). Sphenotic somewhat trapezoid, contacting parieto-supraoccipital dorsally, pterotic-extrascapular posteriorly, second infraorbital posteroventrally and frontal anteriorly (Figs. 2A, 3). Pterotic-extrascapular roughly pipe-shaped, with posterodorsal portion contacting first lateral-line ossicle, posteroventral margin contacting cleithrum, and anteroventral margin contacting opercle and infraorbital 2; anteroventral margin not contacting infraorbital 2 in juvenile

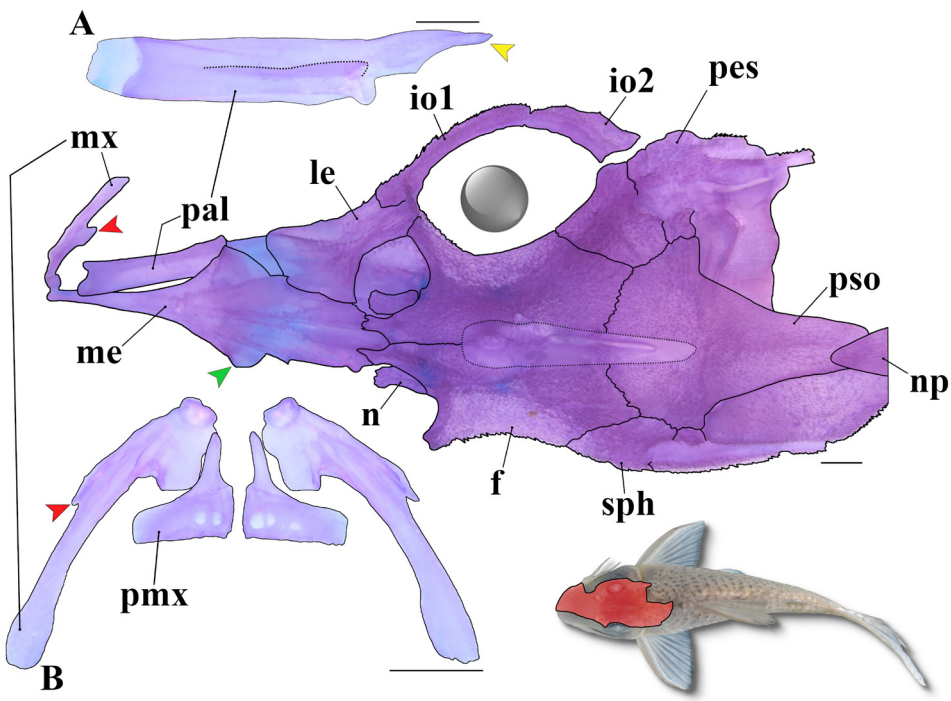

FIGURE 3 | Dorsal view of the head of a c&s paratype of *Corydoras iiap*, MNRJ 55393, 50.4 mm SL, showing general osteological pattern, with the detail of (**A**) the palatine in dorsal view, and of (**B**) the upper jaw in frontal view (= dorsal view considering everted mouth). Abbreviations: f: frontal, io1–2: infraorbital 1 and 2, le: lateral ethmoid, me: mesethmoid, mx: maxilla, n: nasal, np: nuchal plate, pal: palatine, pes: pterotic-extrascapular, pmx: premaxilla, pso: parieto-supraoccipital, sph: sphenotic. Red arrows indicate laminar process on posterolateral portion of maxilla; green arrow indicates lateroventral process of mesethmoid; yellow arrow indicates posterolateral process of palatine. Dotted line in (**A**) outlining dorsolateral longitudinal laminar expansion of palatine. Area where the illustrated bones are located in fish's body marked in red in the miniature photo of a paratype (CIIAP 2913, 55.2 mm SL). Scale bars = 1 mm.

c&s specimen (MNRJ 55393, 41.5 mm SL); 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. 2A, 3). 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. 3).

Two laminar infraorbitals with minute odontodes. Infraorbital 1 large, ventral laminar expansion typically ranging from poorly to moderately developed; strongly reduced in juvenile c&s specimen (MNRJ 55393, 41.5 mm SL); anterior portion with laminar expansion ranging from poorly developed, slightly surpassing posterior margin of nasal capsule, to well-developed, reaching anterior margin of nasal capsule; inner laminar expansion strongly reduced (Figs. 2A, 4A, B). Infraorbital 2 small, widened dorsally, with posterior laminar expansion typically moderately developed; poorly developed in juvenile c&s specimen (MNRJ 55393, 41.5 mm SL); posteroventral margin contacting posterodorsal ridge of hyomandibula, posterior portion contacting opercle, posterodorsal edge contacting sphenotic and pterotic-extrascapular; posterior portion not in direct contact with opercle and poterodorsal edge contacting only sphenotic in juvenile c&s specimen (MNRJ 55393, 41.5 mm SL); inner laminar expansion strongly reduced (Figs. 2A, 4A, B). Posterodorsal ridge of hyomandibula close to its articulation with opercle slender, exposed, and bearing small odontodes (Fig. 4C). Dorsal ridge of hyomandibula between pterotic-extrascapular and opercle entirely covered by thick layer of skin. Interopercle entirely or almost entirely covered by thick layer of skin, variably with small areas of posterior portion exposed and bearing odontodes; subtriangular, anterior projection moderately developed (Fig. 4C). Preopercle elongated, relatively slender; minute odontodes on external surface (Fig. 4C). 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 (Fig. 4C).

Four branchiostegal rays decreasing in size posteriorly. Hypobranchial 1 deep, with mesial expansion well ossified; hypobranchial 2 somewhat triangular, tip ossified and directed towards anterior portion, posterior margin cartilaginous; ossified portion ranging from moderately developed, with size similar to cartilaginous portion, to well developed, around twice size of cartilaginous portion. 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 on posterodorsal surface, with 26 to 27(2) 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. Upper tooth plate roughly oval, 46 to 51(2) teeth aligned in three or four rows on posteroventral surface; rows slightly apart from each other (Fig. 5).

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

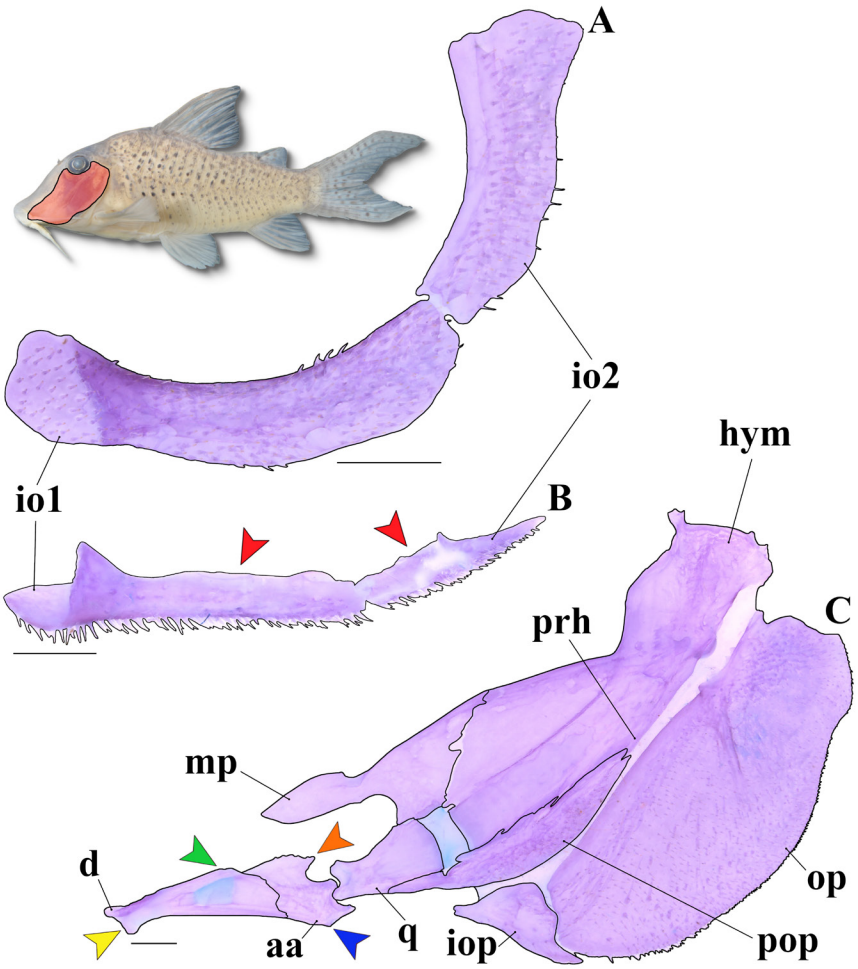

FIGURE 4 | Infraorbital series in lateral (**A**) and dorsal (**B**) views, and (**C**) suspensorium plus operculum in lateral view of a c&s paratype of *Corydoras iiap* (MNRJ 55393, 50.4 mm SL). Abbreviations: aa: angulo-articular, d: dentary, hym: hyomandibula, io1–2: infraorbital 1 and 2, iop: interopercle, mp: metapterygoid, op: opercle, pop: preopercle, prh: posterodorsal ridge of hyomandibula, q: quadrate. Red arrows indicate inner laminar expansion of both infraorbitals; yellow and green arrows indicate anteroventral expansion and posterodorsal process of dentary, respectively; orange and blue arrows indicate dorsal laminar expansion and posteroventral process of anguloarticular, respectively. Area where the illustrated bones are located in fish's body marked in red in the miniature photo of a paratype (CIIAP 2913, 55.2 mm SL). Scale bars = 1 mm.

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 typically with two openings, on posterior and anterior edges of nasal bone. Infraorbital canal running through entire infraorbital 2, extending to infraorbital 1 and typically opening in two 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.

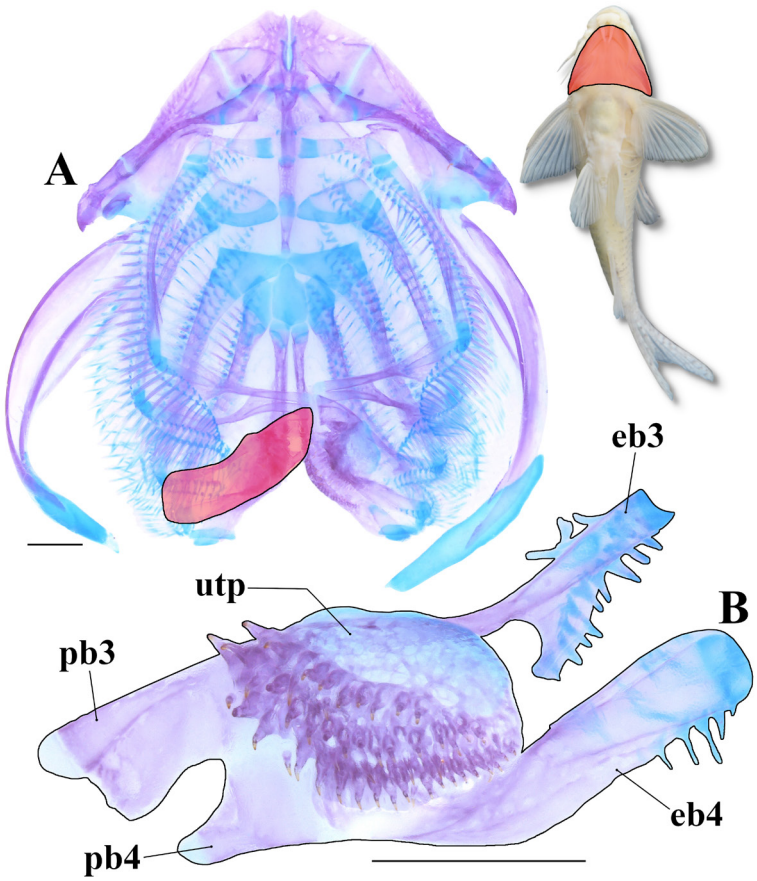

FIGURE 5 | Hyoid and branchial arches in a c&s paratype of *Corydoras iiap* (MNRJ 55393, 41.5 mm SL), showing its general morphology in dorsal view (**A**), with the detail of the upper tooth plate plus pharyngobranchials (3 and 4) and epibranchials 3 and 4 (**B**). Area highlighted in red in (**A**) indicating the position of the bones showed in (**B**) in the branchial basket. Abbreviations: eb3–4: epibranchial 3 and 4, pb3–4: pharyngobranchial 3 and 4, utp: upper tooth plate. Area where the illustrated bones are located in fish's body marked in red in the miniature photo of a paratype (CIIAP 2913, 55.2 mm SL). Scale bars = 1 mm.

Dorsal fin subtriangular, located just posterior to second or third dorsolateral body plate; smaller specimens (up to about 40.0 mm SL) typically with elongated first and second dorsal-fin branched rays. Dorsal-fin rays II,7(1), II,8*(25), posterior margin of dorsal-fin spine with five to 13 strongly reduced to poorly-developed serrations, perpendicularly directed or antrorse; absence of serrations on proximal portion of spine; small odontodes on anterior and lateral surfaces of spine (Fig. 6A). Nuchal plate well developed, almost entirely exposed, with minute odontodes. Spinelet short; spine well developed, with adpressed distal tip typically 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(1), I,10(5), I,10,i(1), I,11*(16), I,11,i(3), 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, especially on proximal portion of spine, variably perpendicularly directed or antrorse; small odontodes on anterior, dorsal and ventral surfaces of spine (Fig. 6B).

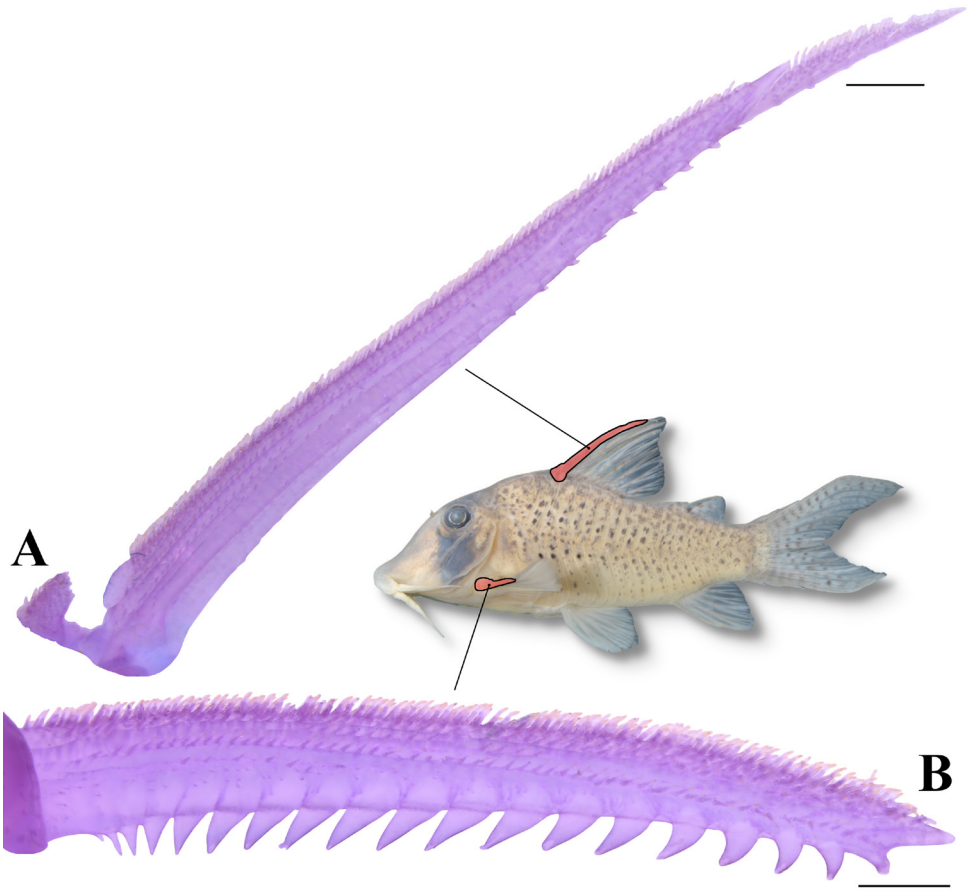

FIGURE 6 | Lateral view of (**A**) the dorsal-fin spine and dorsal view of (**B**) the right pectoral-fin spine in a c&s paratype of *Corydoras iiap* (MNRJ 55393, 50.4 mm SL), showing their respective serration patterns. Area where the illustrated bones are located in fish's body marked in red in the miniature photo of a paratype (CIIAP 2913, 55.2 mm SL). Scale bars = 1 mm.

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, typically located just below second ventrolateral body plate, and at vertical through second dorsal-fin branched rays. Pelvic-fin rays i,5*(26). Anterior internal process of basipterygium well developed and conspicuously laterally expanded, with nearly vertically placed dorsal lamina; anterior external process laminar, moderately to well developed, slightly to moderately expanded posteriorly; dorsal ischiac process well developed, with anterior laminar expansion roughly triangular or rounded, moderately expanded anteriorly, and posterior laminar expansion roughly rounded, slightly to moderately expanded posteriorly; ventral ischiac process clearly smaller than dorsal process, roughly triangular, bent anteriorly (Fig. 7). Adipose fin roughly triangular, separated from base of last dorsal-fin ray by six or seven dorsolateral body

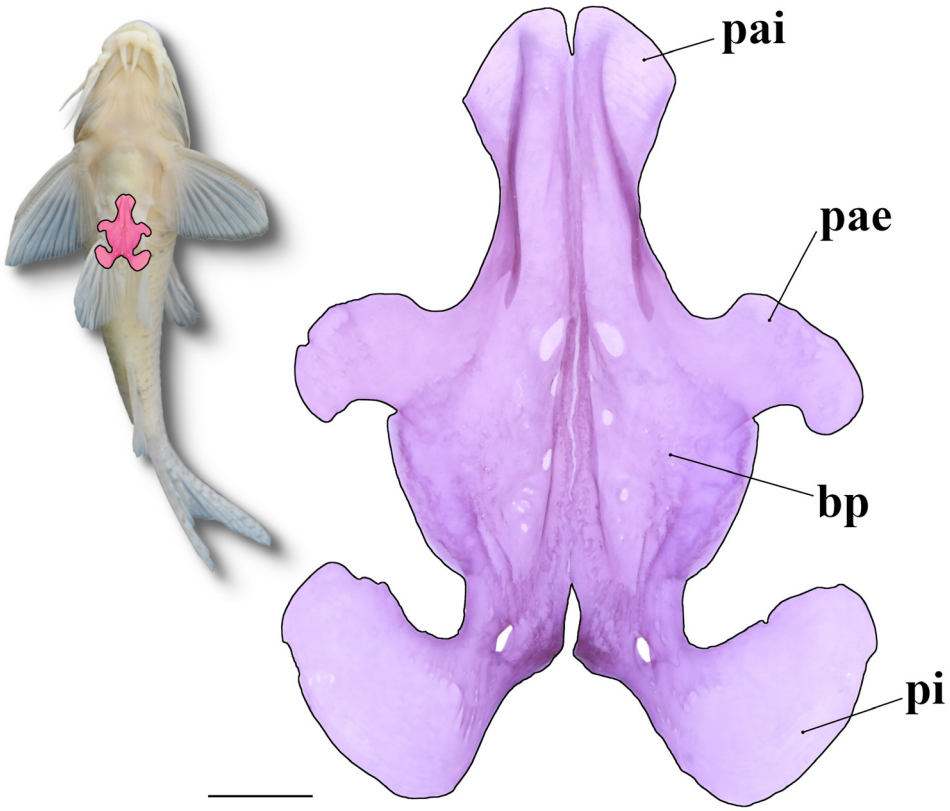

FIGURE 7 | Pelvic girdle in a c&s paratype of *Corydoras iiap* (MNRJ 55393, 50.4 mm SL). Abbreviations: bp: basipterygium, pae: anterior external process, pai: anterior internal process, pi: dorsal ischiac process. Area where the illustrated bones are located in fish's body marked in red in the miniature photo of a paratype (CIIAP 2913, 55.2 mm SL). Scale bar = 1 mm.

plates. Anal fin subtriangular, located just posterior to 12th or 13th ventrolateral body plates, and at vertical through adipose-fin spine base. Anal-fin rays ii,6*(26). Caudal fin bilobed, with dorsal lobe typically larger than ventral lobe. Caudal-fin rays i,12,i*(23), i,13,i(3), typically with four dorsal and ventral procurrent rays; small cartilage between upper principal and procurrent caudal-fin rays (presumably opisthural cartilage (Monod, 1968; McDowall, 1999)) (Fig 8).

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 22(5), 23(13), 24*(7), 25(1). Ventrolateral body plates 20(1), 21*(17), 22(8). Dorsolateral body plates along dorsal-fin base 6*(5), 7(20), 8(1). Dorsolateral body plates between adipose- and caudal-fin 7*(6), 8(16), 9(4). Preadipose platelets 4*(10), 5(14). 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

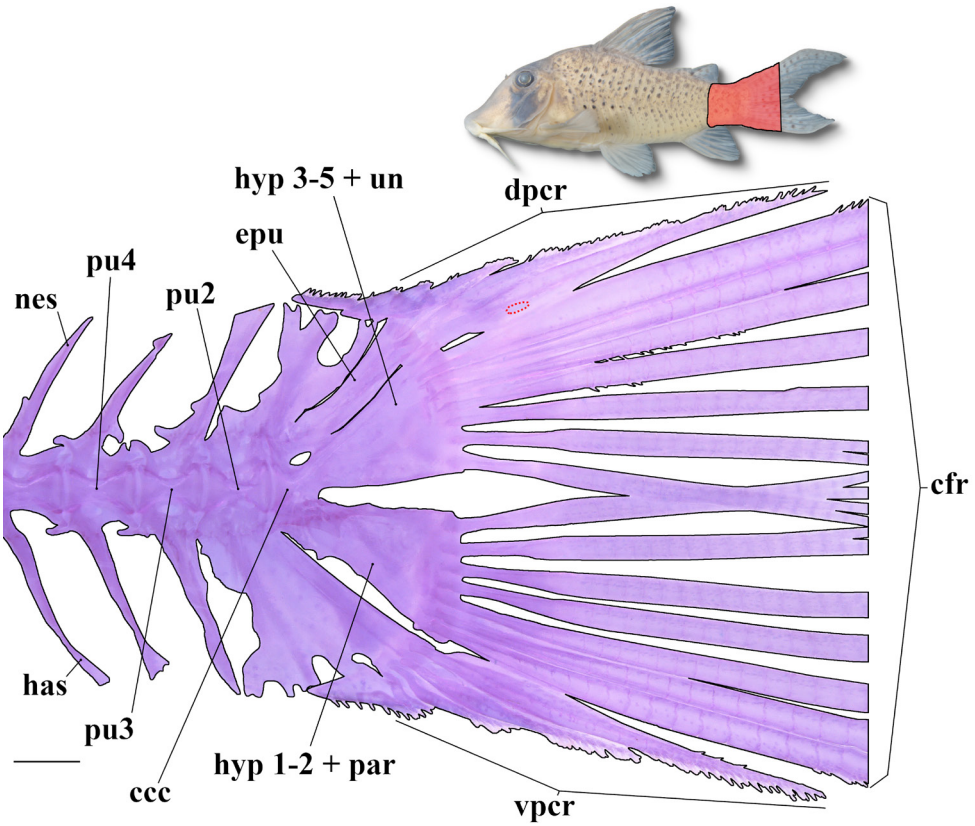

FIGURE 8 | General morphology of the caudal skeleton in a c&s paratype of *Corydoras iiap* (MNRJ 55393, 41.5 mm SL), showing the small cartilage (red dotted line) between upper principal and procurrent caudal-fin rays. Abbreviations: ccc: compound caudal centrum, cfr: caudal-fin principal rays, dpcr: 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. Area where the illustrated bones are located in fish's body marked in red in the miniature photo of a paratype (CIIAP 2913, 55.2 mm SL). Scale bar = 1 mm.

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 head below infraorbital 1, and lateral and dorsal portions of snout with small platelets bearing odontodes; platelets on snout clearly more numerous on its lateral surface (Fig. 2A); smaller specimen (MNRJ 55393, 41.5 mm SL) lacking platelets on dorsal and lateral portions of snout. Ventral surface of head and trunk densely covered by small irregular platelets bearing odontodes (Fig. 9); ventral surface of head and trunk with fewer platelets, more concentrated anteriorly, in smaller specimen (MNRJ 55393, 41.5 mm SL).

Vertebral count 22(2); ribs 5(2); 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.

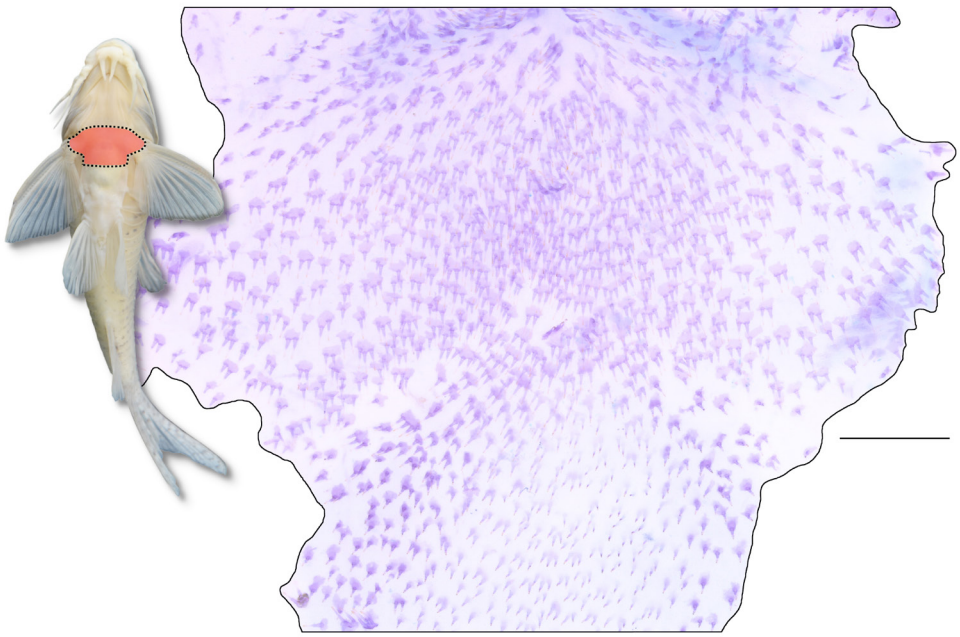

FIGURE 9 | Ventral surface of body in a c&s paratype of *Corydoras iiap* (MNRJ 55393, 50.4 mm SL), showing the presence of numerous small irregular platelets bearing odontodes. Area where the illustrated bones are located in fish's body marked in red in the miniature photo of a paratype (CIIAP 2913, 55.2 mm SL). Scale bar = 1 mm.

Coloration in alcohol. Overall color of body in Fig. 1. Ground color of body pale yellow or beige, with top of head dark brown. Dorsal and lateral surface of head covered by dark brown or black chromatophores, not forming smaller blotches; chromatophores conspicuously more concentrated dorsally and ventrally to orbit, forming wide, conspicuous dark patch transversally crossing orbit (typical mask-like blotch) from parieto-supraoccipital to interopercle region; mask-like blotch smoothly curved anteriorly to nearly straight; region just above posterodorsal margin of orbit slightly darker than dorsal portion of mask-like blotch, forming horizontally elongated eyebrow-like marking, variably nearly straight or slightly arched dorsally, following outline of orbit; eyebrow-like marking variably indistinct from mask-like blotch. Cleithrum with dark brown or black chromatophores, especially on its laterodorsal surface, typically forming small, conspicuous dark brown or black blotches on its posterior border, which can be roughly rounded, irregular or vertically elongated. Dorso- and ventrolateral body plates densely covered by small, conspicuous dark brown or black blotches, variably roughly rounded, irregular or vertically elongated; ventral portion of ventrolateral body plates, especially around pelvic fin, devoid of dark blotches or with fewer and less evident blotches; juvenile specimens (up to about 30.0 mm SL) typically with fewer and more spaced blotches on flanks. Posterior margin of body plates variably with conspicuous concentration of dark brown or black chromatophores, forming thin dark lines. Dorsal, pectoral, pelvic and anal fins with dark brown or black chromatophores, typically not forming dark blotches; dorsal fin with small dark blotches in some specimens, variably diffuse and/or roughly aligned in longitudinal rows; dorsal-fin spine and region of first and second dorsal-fin branched rays, especially in distal portions, of smaller specimens (up to about 40.0 mm SL) typically dark brown

or black; anal fin variably with small, diffuse dark blotches. Adipose and caudal fins with conspicuous concentrations of brown or black chromatophores, typically forming small, dark blotches; caudal-fin blotches roughly aligned in transversal rows, forming slender bars.

Coloration in life. Similar to color pattern of preserved specimens, but with lighter ground color of body and anterior portion of body with bright yellow coloration. Body covered by greenish yellow iridescent coloration (Figs. 10, 11).

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

Geographical distribution. *Corydoras iiap* is only known from tributaries of the Ríos Nanay and Itaya, tributaries of the upper Río Amazonas basin that cross the Iquitos-Nauta Road, district of San Juan Bautista, province of Maynas in the Loreto Region, Peru (Fig. 12).

Ecological notes. *Corydoras iiap* was captured in streams with black, muddy, and mixed waters, all tributaries of the Ríos Itaya and Nanay (Fig. 13). The sampled environments are first-order streams, experiencing constant fluctuations in water level

FIGURE 10 | General color pattern in life of *Corydoras iiap* (CIIAP 2649) in lateral view, showing (**A**) an adult specimen (52.4 mm SL), (**B**) a larger juvenile (28.6 mm SL), and (**C**) a smaller juvenile (19.7 mm SL).

influenced mainly by local rainfall. These aquatic environments presented a width ranging from 4 to 8.1 m and a depth ranging from 0.6 to 1.3 m. The physicochemical parameters of the type-locality on average were: water temperature 26.2°C, pH 6.3, dissolved oxygen 2.4 mg/l, electrical conductivity of 30.5 µS/cm, and total suspended solids 15.0 mg/l. In the case of other localities (see remaining collecting sites within the list of paratypes), the average parameters were: water temperature ranged between 24.5°C and 27.0°C, pH between 5.4 and 5.5, dissolved oxygen between 3.8 and 5.4 mg/l, electrical conductivity between 17.0 and 28.0 µS/cm, and, finally, total suspended solids between 8.0 and 14.0 mg/l. The substrate was mostly composed by sand, with a slight presence of decomposing plant material. In most sampled streams, *Corydoras iiap* was observed in syntopy with *C. sychri* and *C. ambiacus.*

Etymology. The specific epithet "*iiap*" is a reference to the Instituto de Investigaciones de la Amazonía Peruana (IIAP), in Loreto, Peru, which has been the center for the study of the biodiversity of the Peruvian Amazon for over four decades. In appreciation for its invaluable work in conducting biodiversity studies and contributing to the scientific basis for conserving one of the most diverse places on the planet. A noun in apposition.

Conservation status. Although the species presents a currently known relatively restricted geographical distribution in a region with clear signs of anthropogenic impacts (see Remarks section), some of the streams in which the new species inhabits, including its type-locality (quebrada Paujil), are within a protected area, the Allpahuayo Mishana National Reserve. Considering this, and according to the International Union for Conservation of Nature (IUCN) categories and criteria (IUCN Standards and Petitions Subcommittee, 2022), *Corydoras iiap* would be classified as Least Concern (LC).

FIGURE 11 | Uncatalogued aquarium specimens of *Corydoras iiap* (not measured) showing its color pattern in life under aquarium conditions. Photo by Haakon Haagensen.

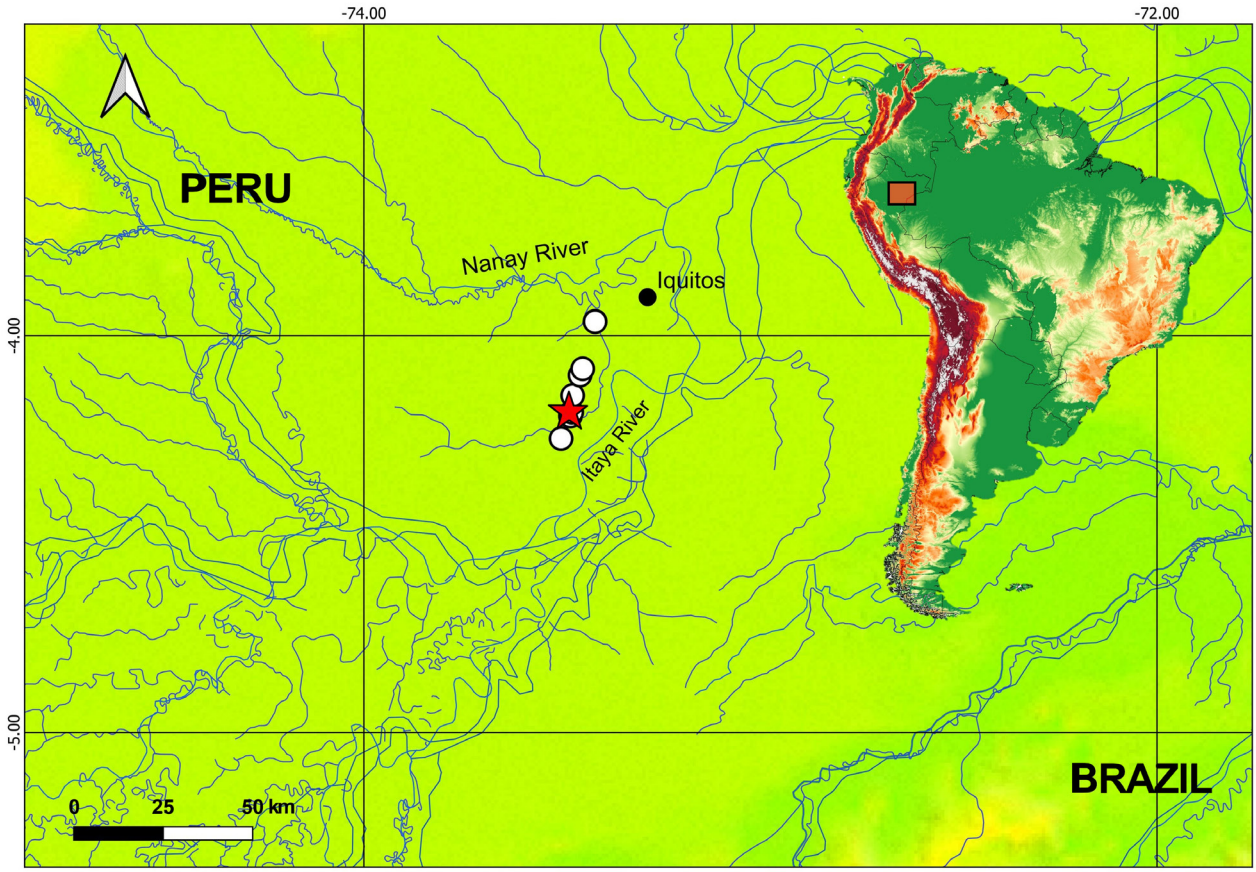

FIGURE 12 | Map showing the geographical distribution of *Corydoras iiap* (red star: type-locality; white circles: additional records). The symbols may represent more than one locality.

Remarks. *Corydoras iiap* was locally marketed in Peru for over 15 years under the name "sicri Luminoso", a clear reference to its mimetic pair, *C. sychri*, being highly cherished and traded in the aquarium hobbyist world (C. Chuquipiondo, 2023, pers. comm.), where it was coded as *Corydoras* sp. C53. Despite suggesting the LC category due to its presence within a National Reserve, it is important to consider the following points: (I) the new species was not abundant in our captures; in each collection effort, we managed to capture between three to eight individuals, suggesting that it does not form large shoals, which seems to be the case of most lineage 1 species (LFCT, pers. obs.), (II) the streams where *Corydoras iiap* was captured showed a slight presence of plastic waste, and (III) the local headwater environments have been fragmented by the construction of the paved road Iquitos–Nauta, which has a length of approximately 100 km and was built over 18 years ago (JC, MRT, pers. obs.). Interestingly, even with extensive fishing efforts, *Corydoras iiap* was not captured in the main channel of the Río Nanay, which indicates that this species tends to occur in smaller water bodies. Therefore, even if there is no threat to the species as a whole due to its occurrence in a preservation area, it is possible that part of its populations is severely affected by human activity, which becomes worrying due to its relatively restricted geographic distribution.

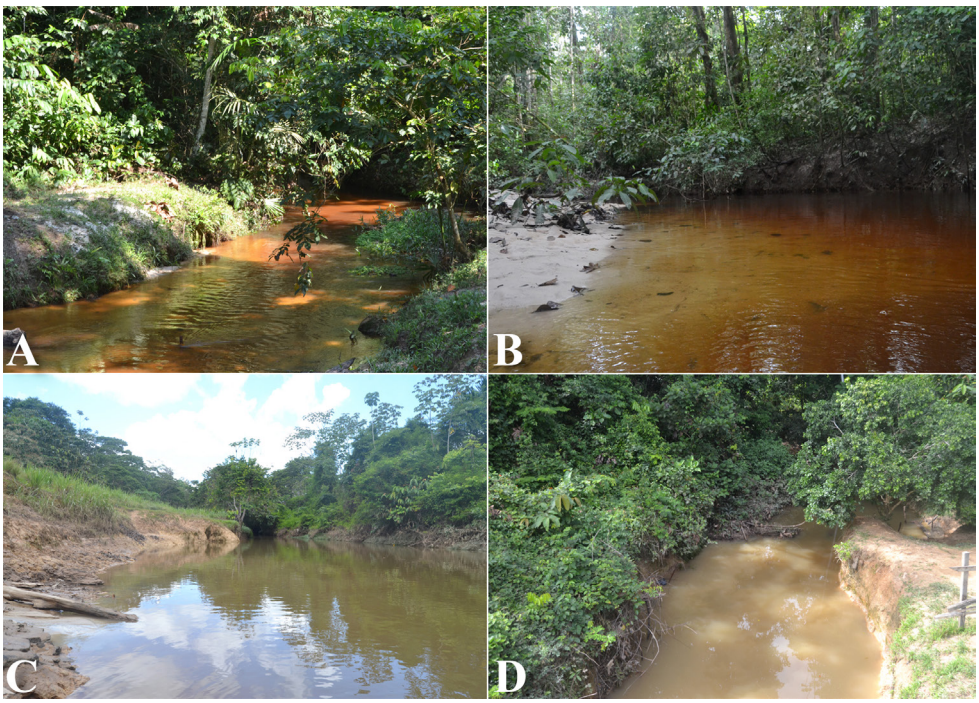

FIGURE 13 | Collecting sites of *Corydoras iiap*, upper Río Amazonas basin, Loreto Region, Peru, showing (**A**) its type-locality, Quebrada Paujil, (**B**) Quebrada Santa Cruz, (**C**) Quebrada Pintuyacu, and (**D**) Quebrada San Pablo. Streams (**A**) and (**B**) tributaries of the Río Nanay basin; (**C**) and (**D**) tributaries of the Río Itaya basin.

DISCUSSION

Peru hosts a relatively high richness of *Corydoras*, now composed of 40 valid species, representing circa 21% of the total number of valid species within *Corydoras*. From these 40 valid species, 25 have their type localities within the Peruvian territory, with more than half of them in the Loreto Region (see Fricke *et al*., 2024). The Río Nanay basin is the type-locality of *C. loretoensis*, putatively of *C. sychri* (see Nijssen, Isbrücker, 1986:72), and of *C. iiap*. Currently, the aquatic environments of the Loreto region are experiencing various anthropogenic impacts affecting the habitats where these species live (JC, MRT, pers. obs.). The right bank tributaries of the Río Nanay basin suffer from habitat fragmentation due to the Iquitos-Nauta Road, introduction of exotic species generated by the increase in fish farms, and impacts caused by improper disposal of solid wastes from the city of Iquitos. Additionally, the headwaters of the Río Nanay basin are experiencing impacts from deforestation and land erosion around lakes and streams due to the increase of illegal mining. In its lower stretch, the main impact is due to the entry of wastewater from the city of Iquitos, negatively affecting streams and lakes near its confluence with the Río Amazonas (Ruiz-Tafur *et al*., 2023). Meanwhile, the right bank tributaries of the Río Itaya suffer from fragmentation impacts and introduction of exotic species, while its lower stretch is impacted by solid waste (microplastics), affecting the health of water bodies. Amidst these two basins, we find the Allpahuayo Mishana National Reserve, which helps safeguard the rich biodiversity of this region and its aquatic environments, thereby increasing the probability of survival of *C. iiap* in these habitats.

Corydoras iiap is overall similar to *C. blochi*, *C. caramater* and *C. saramaccensis*, from which it can be mostly distinguished by details in color pattern. In addition to the dark blotch on anterior portion of dorsal-fin base in *C. blochi* and *C. saramaccensis* (see Diagnosis), it is possible to distinguish the new species from *C. blochi* by the presence of an evident dark patch on anterior portion of dorsal fin (*vs.* dark patch on anterior portion of dorsal fin present only in smaller specimens (up to about 40.0 mm SL) and, when present, clearly less evident in *Corydoras iiap*). When compared to *C. caramater*, the new species present both mask-like blotch and dark blotches on flanks more evident, as well as a more ossified hypobranchial 2 in smaller specimens with up to about 42.0 mm SL (see Diagnosis). Regarding *C. saramaccensis*, it is not clear whether the species actually has the typical mask-like blotch, as such feature is not currently present in the holotype but was apparently depicted in the drawing of the holotype provided in the original description (see Nijssen, 1970:38, fig. 21). In any case, even if such blotch is present, the mask-like blotch is wider and longer, reaching interopercle region in the new species (*vs.* slender and shorter, clearly not reaching interopercle region in *C. saramaccensis*).

Considering only general color pattern, the new species mostly resembles *C. atropersonatus* and *C. sychri*, from which it can be promptly distinguished by having the exclusive features shared by all lineage 1 species *sensu* Alexandrou *et al.* (2011): (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 series of teeth (*vs.* two series); and (III) area at the corner of the mouth, ventral to the maxillary barbel, with a small, triangular fleshy flap, which may variably present a small prolongation at its posterior tip, forming a short barbel-like structure (*vs.* fleshy flap absent). As aforementioned, these species occur in sympatry in the Río Nanay basin, but can also be eventually found in syntopy in some sites, typically forming pairs (the simultaneous occurrence of the three species was not reported yet).

Syntopic pairs, or even trios, of similarly colored species presenting clearly different morphology is a widely known phenomenon within Corydoradinae (Nijssen, Isbrücker, 1980a,c; Grant, 1997; Britto, 2003; Britto *et al*., 2009; Alexandrou *et al*., 2011; Tencatt *et al*., 2013, 2019, 2021, 2022a, 2023, 2024; Tencatt, Pavanelli, 2015; Tencatt, Britto, 2016; Tencatt, Ohara, 2016a,b; Lima, Sazima, 2017). This topic was deeply discussed by Alexandrou *et al*. (2011), who provided a molecular-based phylogenetic hypothesis that allowed the establishment of 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*. Despite the substantial improvement on the systematics of the group generated by the work of Alexandrou *et al*. (2011), their results could not be entirely corroborated by morphological data, especially considering the relatively distant position of lineages 6 and 9, clades harboring very similar species (see Tencatt, Ohara, 2016b).

Morphological diagnoses for most "*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), except for lineages 6 and 9, which could not be distinguished from each other based on the currently available morphological data. Even though such diagnoses are available and the paraphyly of *Corydoras* have been continuously demonstrated (*e.g.*, Reis, 1998; Britto, 2003; Alexandrou *et al*., 2011; Marburger *et al*., 2018), the classification of Corydoradinae still follows Britto

(2003). This 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 in the current main phylogenetic reference for the group (*i.e.*, Alexandrou *et al.*, 2011).

Interestingly, the two most recent studies dealing with the phylogeny of Corydoradinae diverge from Alexandrou *et al.* (2011), first by Marburger *et al.* (2018), with a nuclear-based phylogenetic hypothesis (pyRAD), and then by Dias (2022), with basis on Ultraconserved Elements, mostly corroborating the morphological data. In these studies, lineages 6 and 9 *sensu* Alexandrou *et al.* (2011) form a monophyletic group, the *Hoplisoma* Swainson, 1838 clade, which basically removes the major obstacle for a novel classification for Corydoradinae as both molecular and morphological approaches became congruent. Considering this, a broad study including both morphological and molecular data is being carried out by Dias *et al.* (*in press*), 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 (see first section of Diagnosis and second paragraph of Discussion) undoubtedly places *Corydoras iiap* as a member of the *Corydoras* clade (= lineage 1 *sensu* Alexandrou *et al.*, 2011). Therefore, even with the publication of Dias *et al.*'s work, the new species will remain allocated in *Corydoras*.

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The author declares no competing interests.

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