

A new species of *Corydoras* Lacépède, 1803 (Siluriformes: Callichthyidae) from the río Madre de Dios basin, Peru

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A new species of *Corydoras* is described from the río Madre de Dios basin, Peru. The new species can be distinguished from its congeners by presenting the following features: a longitudinal black stripe along midline of flank; mesethmoid short, with anterior portion poorly developed; serrations on posterior margin of pectoral spine directed towards the tip of the spine; dorsal fin with the region of the first branched ray, including membrane, with concentration of black pigmentation, the remaining areas with irregular black blotches; absence of a vertically elongated black blotch across the eyes; conspicuously rounded moderately-developed black spots on the snout; and ventral expansion of infraorbital 1 moderately developed.

Uma espécie nova de *Corydoras* é descrita da bacia do rio Madre de Dios, Peru. A espécie nova pode ser distinguida de suas congêneres por apresentar as seguintes características: uma faixa preta longitudinal ao longo da linha mediana do flanco; mesetmóide curto, com porção anterior pouco desenvolvida; serrilhas na margem posterior do espinho peitoral voltadas em direção à ponta do espinho; região do primeiro raio ramificado da nadadeira dorsal, incluindo membranas, com concentração de pigmentação preta, as demais áreas com manchas pretas irregulares; ausência de uma mancha preta verticalmente alongada através dos olhos; manchas pretas moderadamente desenvolvidas, conspicuamente arredondadas, no focinho; e expansão ventral do infraorbital 1 moderadamente desenvolvida.

Keywords: Corydoradinae, CW32, rio Amazonas basin, rio Inambari basin, rio Madeira basin, Taxonomy.

Introduction

The Callichthyidae are small- to medium-sized catfishes that are easily recognizable by the presence of two longitudinal series of dermal plates on the flanks. Currently comprised of more than 200 species, the family is split into eight genera (Reis, 2003; Eschmeyer, 2015). *Corydoras* Lacépède, 1803 is the largest of these genera, harboring more than 170 species, making it the most species-rich genus of Siluriformes (Reis, 2003; Eschmeyer, 2015). The first comprehensive taxonomic studies involving *Corydoras* began over 70 years ago with the revisionary work of Gosline (1940), which performed a taxonomic review of Callichthyidae. Thirty years later, the next extensive study was published by Nijssen (1970), with the review of the *Corydoras* species from Suriname. Additionally, Nijssen (1970) also proposed nine groups of species based mainly in color pattern and external morphology. Nijssen & Isbrücker (1980) carried out a review of *Corydoras*, making some reformulations in Nijssen's (1970) species groups, reducing them from nine down to five.

The first phylogenetic study encompassing a large number of *Corydoras* species was conducted by Britto (2003). His work on Corydoradinae revealed a large polytomy among

Corydoras with most species grouped into nine clades. Britto's (2003) results also pointed *Scleromystax* Günther, 1864 as valid and sister-group of *Aspidoras* Ihering, 1907. Additionally, *Corydoras* was found paraphyletic, therefore, *Brochis* Cope, 1871 was placed in its synonymy in order to maintain the monophyly of *Corydoras*. Alexandrou *et al.* (2011) studied the correlation of competition and phylogenetic relationships in the community structure of Müllerian co-mimics species of Corydoradinae. This work presented an extensive phylogenetic hypothesis which corroborates the paraphyly of *Corydoras*, revealing nine clearly different lineages of species. Contrary to Britto's (2003) work, Alexandrou *et al.* (2011) study does not present a taxonomic approach and by this reason they do not proposed any taxonomic change in order to maintain the monophyly of *Corydoras*.

Currently, 29 valid *Corydoras* species occur in the Peruvian Amazon basin: *C. acutus* Cope, 1872, *C. aeneus* (Gill, 1858), *C. agassizii* Steindachner, 1876, *C. ambiacus* Cope, 1872, *C. amphibelus* Cope, 1872, *C. arcuatus* Elwin, 1938, *C. armatus* (Günther, 1868), *C. atropersonatus* Weitzman & Nijssen, 1970, *C. copei* Nijssen & Isbrücker, 1986, *C. coriatae* Burgess, 1997, *C. elegans* Steindachner, 1876, *C. fowleri* Böhlke, 1950, *C. lamberti* Nijssen &

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Isbrücker, 1986, *C. leopardus* Myers, 1933, *C. leucomelas* Eigenmann & Allen, 1942, *C. loretoensis* Nijssen & Isbrücker, 1986, *C. multiradiatus* (Orcés-Villagomes, 1960), *C. napoensis* Nijssen & Isbrücker, 1986, *C. ortegai* Britto, Lima & Hidalgo, 2007, *C. panda* Nijssen & Isbrücker, 1971, *C. semiaquilus* Weitzman, 1964, *C. sodalis* Nijssen & Isbrücker, 1986, *C. splendens* (Castelnau, 1855), *C. stenocephalus* Eigenmann & Allen, 1942, *C. sychri* Weitzman, 1960, *C. trilineatus* Cope, 1872, *C. virginiae* Burgess, 1993, *C. weitzmani*, Nijssen 1971, and *C. zygatus* Eigenmann & Allen, 1942 (see Eschmeyer, 2015). After the analysis of *Corydoras* specimens from the rio Madre de Dios basin, Peru, a new species was revealed, which is described herein.

Material and Methods

Measurements were obtained by the use of digital calipers to the nearest tenth of a millimeter. Morphometric and meristic data were taken following Reis (1997), with modifications of Tencatt *et al.* (2013). Morphometrics are reported as percentages of standard length (SL) and head length (HL). Homology of barbels follows Britto & Lima (2003). 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), compound pterotic instead of pterotic-supracleithrum (Aquino & Schaefer, 2002), and scapulocoracoid instead of coracoid (Lundberg, 1970). Nomenclature of latero-sensory canals and preopercular pores are according to Schaefer & Aquino (2000) and Schaefer (1988), respectively. The supra-preopercle *sensu* Huysentruyt & Adriaens (2005) will be treated here as a part of the hyomandibula according to Vera-Alcaraz (2013). Vertebral counts followed Britto *et al.* (2009).

Comparative data of *Corydoras acrensis* Nijssen, 1972, *C. baderi* Geisler, 1969, *C. boesemani* Nijssen & Isbrücker, 1967, *C. coppenamensis* Nijssen, 1970, *C. gomezi* Castro, 1986, *C. habrosus* Weitzman, 1960, *C. haraldschultzi* Knaack, 1962, *C. isbrueckeri* Knaack, 2004, *C. leopardus*, *C. noelkempffi* Knaack, 2004, *C. ornatus* Nijssen & Isbrücker, 1976, *C. orphnopterus* Weitzman & Nijssen, 1970, and *C. sipaliwini* Hoedeman, 1965 were obtained through their original descriptions and/or high resolution photographs of type-specimens hosted in the Natural History Museum, London. Other photographs examined are available from Morris *et al.* (2006).

In the description, numbers between brackets represent the total number of specimens with those counts. Numbers with an asterisk refer to the counts of the holotype. Institutional abbreviations are:

Asociación Ictiológica de La Plata (AI), La Plata; Academy of Natural Sciences of Drexel University (ANSP), Philadelphia; Natural History Museum (BMNH), London; Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus;

Laboratório de Biologia de Peixes da Universidade Estadual Paulista “Júlio de Mesquita Filho” (LBP), Botucatu; Museu de Ciências e Tecnologia da Pontifícia Universidade Católica do Rio Grande do Sul (MCP), Porto Alegre; Museum of Comparative Zoology (MCZ), Harvard University, Cambridge; Museu Nacional, Universidade Federal do Rio de Janeiro (MNRJ), Rio de Janeiro; Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos (MUSM), Lima; Museu de Zoologia da Universidade de São Paulo (MZUSP), São Paulo; Naturhistoriska Riksmuseet (NRM), Stockholm; Coleção Ictiológica do Núcleo de Pesquisas em Limnologia, Ictiologia e Aquicultura da Universidade Estadual de Maringá (NUP), Maringá; Royal Ontario Museum (ROM), Toronto; Coleção Zoológica de Referência da Universidade Federal de Mato Grosso do Sul (ZUFMS-PIS), Campo Grande.

Results

Corydoras knaacki, new species

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(Figs. 1-5, Table 1)

Holotype. MUSM 52730 35.6 mm SL, Peru, Madre de Dios, Santa Rita, swamps in the vicinity of the town of Santa Rita, draining into the rio Inambari, rio Madre de Dios basin, 12°54'46.4"S 70°10'37.4"W, 19 Aug 2014, H.-G. Evers.

Paratypes. All from Peru, Madre de Dios Department, rio Madre de Dios basin. INPA 46982, 4, 24.5-31.0 mm SL; MNRJ 42888, 1, 24.6 mm SL; MNRJ 42889, 4, 17.2-27.2 mm SL; MZUSP 117378, 4, 20.7-28.4 mm SL; NUP 17307, 6, 22.1-36.9 mm SL; NUP 17308, 3 c&s, 34.0-36.9 mm SL; ZUFMS-PIS 4035, 7, 20.7-34.7 mm SL, collected with the holotype. ROM 82925, 1, 37.0 mm SL, Martin Pescador stream, 11°49'60"S 71°20'60"W, 1 Oct 1991, H. Ortega & F. Zambrano. ROM 82929, 12, 29.8-39.6 mm SL, Martin Pescador stream, 11°49'60"S 71°20'60"W, 14 Oct 1991, H. Ortega & M.E. Guevara. ROM 82932, 4, 31.5-38.2 mm SL, stream tributary to the rio Manu, Oct 1991, H. Ortega & M.E. Guevara.

Diagnosis. *Corydoras knaacki* can be distinguish from its congeners, with exception of *C. acrensis*, *C. baderi*, *C. bifasciatus* Nijssen, 1972, *C. boesemani*, *C. bondi*, *C. coppenamensis*, *C. gomezi*, *C. habrosus*, *C. haraldschultzi*, *C. incolicana* Burgess, 1993, *C. isbrueckeri*, *C. julii*, *C. leopardus*, *C. nattereri*, *C. noelkempffi*, *C. ornatus*, *C. orphnopterus*, *C. pinheiroi* Dinkelmeyer, 1995, *C. pulcher*, *C. robineae* Burgess, 1983, *C. robustus*, *C. sipaliwini*, *C. sterbai* and *C. trilineatus*, by the presence of a longitudinal black stripe along midline of flank (vs. midline of flank

unspotted; with spots; not forming a conspicuous stripe); from *C. bifasciatus*, *C. gomezi*, *C. haraldschultzi*, *C. incolicana*, *C. isbrueckeri*, *C. leopardus*, *C. noelkempffi*, *C. ornatus*, *C. orphnopterus*, *C. pinheiroi*, *C. pulcher*, *C. robineae*, and *C. robustus* by the presence of a short mesethmoid, with anterior portion smaller than 50% of the bone length (*vs.* long, equal or larger than 50% of the bone length); and serrations on posterior margin of the pectoral spine directed towards the tip of the spine (*vs.* directed towards the origin of the spine); from *C. acrensis*, *C. baderi*, *C. habrosus*, *C. julii*, *C. nattereri*, *C. sterbai* and *C. trilineatus* by the presence of black pigmentation on the first branched ray, including membrane, the remaining areas with irregular black blotches (*vs.* anterodorsal portion of dorsal fin with a large black blotch, the remaining

areas with irregular black spots in *C. acrensis*, *C. julii* and *C. trilineatus*; dorsal fin entirely hyaline in *C. baderi*; dorsal fin covered by black spots in *C. habrosus* and *C. sterbai*; dorsal fin brownish, without blotches; membranes covered by black chromatophores, more concentrated on its anteriormost portion in *C. nattereri*). Additionally, *C. knaacki* can be distinguished from *C. boesemani* by the absence of a vertically elongated black blotch across the eyes (*vs.* presence); from *C. bondi* and *C. sipaliwini* by the presence of conspicuously rounded moderately-developed black spots on the snout (*vs.* irregular small black spots; or scattered black chromatophores, in *C. bondi*; larger irregular black spots in *C. sipaliwini*); from *C. copenamensis* by the presence of ventral expansion of infraorbital 1 moderately developed (*vs.* well developed).



Fig. 1. *Corydoras knaacki*, holotype, MUSM 52730, 35.6 mm SL, Peru, Madre de Dios, Santa Rita, swamps in the vicinity of the town of Santa Rita, draining into the río Inambari, río Madre de Dios basin, 12°54.774'S 70°10.624'W. Dorsal (top), lateral (middle) and ventral (bottom) views. Photo by Celso Ikedo.

Description. Morphometric data presented in Table 1. Head compressed with convex dorsal profile; triangular in dorsal view. Snout short and markedly rounded. Head profile convex from tip of snout to anterior nares; ascending, smoothly convex from this point to tip of posterior process of parieto-supraoccipital; region of posterior process of parieto-supraoccipital nearly straight; slightly convex in some specimens. Profile slightly convex along dorsal-fin base. Postdorsal-fin body profile nearly straight to adipose-fin spine; markedly concave from this point to caudal-fin base. Ventral profile of body slightly convex from isthmus to pelvic girdle. Profile nearly straight from pelvic girdle to base of first anal-fin ray; abruptly concave to caudal-fin base. Body roughly elliptical in cross section at pectoral girdle, gradually becoming more compressed toward caudal fin.

Eye rounded, located dorso-laterally on head; orbit delimited dorsally by lateral ethmoid, frontal and sphenotic, ventrally by infraorbitals. 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 equal to diameter of naris. Mouth small, subterminal, width nearly equal to bony orbit diameter. Maxillary barbel moderate in size, not reaching anteroventral limit of gill opening. Outer mental barbel slightly larger than maxillary barbel. Inner mental barbel fleshy, with base close to its counterpart. Small rounded papillae covering entire surface of all barbels, upper and lower lips, and isthmus.

Table 1. Morphometric data of *Corydoras knaacki*. N = number of specimens and SD = standard deviation.

	N	Holotype	Low-High	Mean±SD
Standard length (mm)	20	35.6	17.2-36.9	27.8±6.4
Percentages of standard length				
Depth of body	20	40.2	38.9-45.7	42.1±1.9
Predorsal distance	20	52.2	51.0-56.1	53.0±1.4
Prepelvic distance	20	47.8	45.4-52.2	48.8 ±2.1
Preanal distance	20	82.6	79.9-84.8	81.9±1.5
Preadipose distance	20	86.2	84.3-88.6	86.3±1.1
Length of dorsal spine	20	25.8	18.4-34.3	26.8±3.7
Length of pectoral spine	20	29.5	23.3-34.3	29.6±2.8
Length of adipose-fin spine	20	7.9	6.8-10.4	8.3±1.0
Depth of caudal peduncle	20	15.2	15.2-18.3	16.4±0.8
Length of dorsal-fin base	20	19.7	15.1-20.1	18.3±1.4
Dorsal to adipose distance	20	21.3	15.5-25.2	19.7±2.6
Maximum cleithral width	20	30.1	28.3-32.2	30.1±1.3
Head length	20	46.1	45.3-49.5	47.3±1.4
Length of maxillary barbel	17	8.4	8.4-14.0	11.3±1.9
Percentages of head length				
Head depth	20	83.5	79.5-91.1	84.7±3.3
Least interorbital distance	20	34.1	30.8-36.4	33.1±1.4
Horizontal orbit diameter	20	21.3	20.5-26.7	23.9±1.9
Snout length	20	34.1	31.2-37.1	34.4±1.5
Least internarial distance	20	20.1	11.1-20.8	17.2±2.4

Mesethmoid short; anterior tip poorly developed, smaller than 50% of bone length (see Britto, 2003: 123, character 1, state 1; fig. 1B); posterior portion relatively narrow, partially exposed and bearing minute odontodes. Nasal slender, curved laterally, with inner margin laminar; mesial border contacting frontal and mesethmoid. Frontal elongated, narrow, with width slightly smaller than half of entire length; anterior projection short, size smaller than nasal length. Frontal fontanel large, oval; posterior tip extension slightly entering anterior margin of parieto-supraoccipital. Parieto-supraoccipital wide, posterior process long and contacting nuchal plate; region of contact between posterior process and nuchal plate covered by thick layer skin.

Two laminar infraorbitals with minute odontodes; infraorbital 1 large, ventral laminar expansion moderately developed; anterior portion with moderately-developed expansion (Fig. 2a, b); infraorbital 2 small, slender; with posterior laminar expansion moderately developed; posteroventral margin contacting posterodorsal ridge of hyomandibula, dorsal tip contacting only sphenotic (Fig. 2c); contacting sphenotic and compound pterotic in some specimens (Fig. 2d). Posterodorsal ridge of hyomandibula close to its articulation with opercle oblong; exposed, slightly thickened and bearing small odontodes; dorsal ridge of hyomandibula between compound pterotic and opercle entirely or almost entirely covered by a thick layer of skin. Interopercle entirely covered by thick layer of skin, somewhat triangular, anterior projection well-developed. Preopercle slender, elongated, minute odontodes sparse on external surface. Opercle dorso-ventrally elongated, width nearly equal to half of its length; free margin convex, without serrations and covered by small odontodes. Anteroventral portion of cleithrum and posterolateral portion of scapulocoracoid exposed; minute odontodes sparse on exposed areas. Vertebral count 21 (3); ribs 6 (3), first pair conspicuously large; complex vertebra compact in shape. Neural and haemal spines with expanded in distal tips.

Four branchiostegal rays decreasing in size posteriorly. Hypobranchial 2 somewhat triangular, tip ossified and directed towards anterior portion, posterior margin cartilaginous; ossified portion well developed, about twice size of cartilaginous portion. Five ceratobranchials with expansions increasing posteriorly; ceratobranchial 1 with small process on anterior margin of mesial portion; ceratobranchial 3 with continuous postero-lateral margin; ceratobranchial 5 toothed on postero-dorsal surface, 36 to 45 (3) 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 curved mesially uncinat process on laminar expansion of posterior margin. Two wide pharyngobranchials (3 and 4), pharyngobranchial 3 with irregular laminar expansion on posterior margin. Upper tooth plate oval; 38 to 43 (3) teeth aligned in two rows on postero-ventral surface.

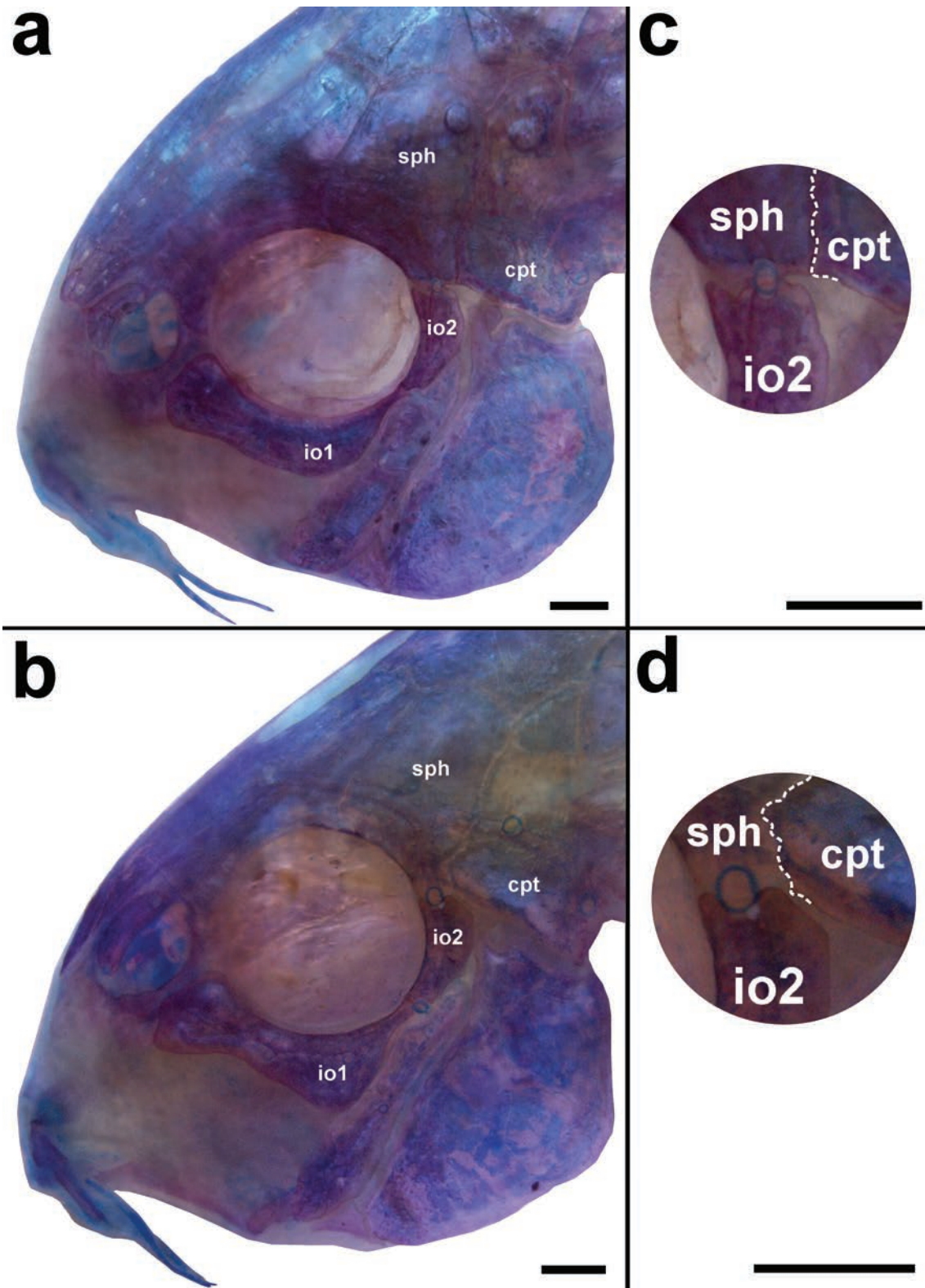


Fig. 2. Lateral view of the head of c&s specimens of *Corydoras knaacki*, showing the moderately-developed ventral expansion of the infraorbital 1 in (a) NUP 17308, 36.9 mm SL, and (b) NUP 17308, 35.9 mm SL. Additionally, the two variable condition in which (c) the infraorbital 2 do not contact compound pterotic and (d) in which the contact of infraorbital 2 contacts compound pterotic are also displayed. The dotted lines in (c) and (d) represent the suture between sphenotic and compound pterotic. Abbreviations: io1: infraorbital 1, io2: infraorbital 2, sph: sphenotic, cpt: compound pterotic. Scale bar = 1.0 mm.

Lateral-line canal entering neurocranium through compound pterotic, splitting into two branches before entering sphenotic: pterotic branch with a single pore; preoperculomandibular branch conspicuously reduced, with a single pore opening close to postotic main canal. Sensory canal continuing through compound pterotic, entering sphenotic as temporal canal, which splits into two branches: one branch giving rise to infraorbital canal, other branch entering frontal through supraorbital canal, both with a single pore. Supraorbital canal not branched, running through nasal bone. Epiphyseal pore opening at supraorbital main canal. Nasal canal with three openings, first on posterior edge, second on posterolateral portion and third on anterior edge. Infraorbital canal running through entire second infraorbital, extending to infraorbital 1 and opening into 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.

Dorsal fin triangular, located just posterior to second dorsolateral body plate. Dorsal-fin rays II,7 (1), II,8* (19), posterior margin of dorsal-fin spine with 10 to 14 serrations directed towards tip of spine; serrations absent proximally. Nuchal plate moderately developed; exposed, with minute odontodes; spinelet short; spine moderately developed, adpressed distal tip reaching to or slightly surpassing origin of last dorsal-fin branched ray; anterior margin with small odontodes. Pectoral fin triangular, its origin just posterior to gill opening. Pectoral-fin rays I,7* (15), I,8 (5); posterior margin of pectoral spine with 21 to 27 small serrations along its entire length; serrations directed towards pectoral-spine tip (Fig. 3). Pelvic fin oblong, located just below first ventrolateral body plate, and at vertical through first branched dorsal-fin ray. Pelvic-fin rays i,5. Adipose fin roughly triangular, separated from base of last dorsal-fin ray by generally seven dorsolateral body plates. Anal fin triangular, located just posterior to 12th ventrolateral body plates, and at vertical through anterior margin of adipose-fin spine. Anal-fin rays ii,5* (3), ii,5,i (15), ii,6 (1), ii,6,i (1). Caudal-fin rays i,11,i (1), i,12,i* (19), generally four dorsal and ventral procurrent rays; bilobed; dorsal lobe slightly larger than ventral lobe.



Fig. 3. Pectoral-fin spine of *Corydoras knaacki*, NUP 17308, 35.9 mm SL, showing the serrations on posterior margin of the right spine (9.6 mm long).

Two or three laterosensory canals on trunk; first ossicle tubular, second ossicle laminar, and third lateral-line canal, if present, encased in third dorsolateral body

plate. Body plates with minute odontodes scattered over exposed area, a conspicuous line of odontodes confined on posterior margins; dorsolateral body plates 22 (2), 23* (16), 24 (2); ventrolateral body plates 20 (12), 21 (8); dorsolateral body plates along dorsal-fin base 6; dorsolateral body plates between adipose- and caudal-fin 6 (1), 7* (15), 8 (4); preadipose platelets 2* (11), 3 (9); 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 with platelets above lateral ethmoid. Ventral surface of trunk generally without platelets; few specimens with scarce small platelets.

Color in alcohol. Overall color pattern in Figure 1. Ground color of body grayish yellow, with top of head and snout dark brown. Ventral margin of orbit, above infraorbital 1, blackened. Maxillary barbel covered by black chromatophores. Dorsal and lateral portion of head, dorsal two thirds of dorsolateral body plates anterior to adipose fin, cleithrum and dorsal portion of ventrolateral body plates anterior to dorsal fin with conspicuously rounded black spots. Dorsal portion of ventrolateral body plates between dorsal-fin origin and adipose-fin origin with vertically elongated black spots. Dorsal portion of caudal peduncle close to caudal-fin origin blackened. Midline of flank posterior to dorsal-fin origin with longitudinal black stripe; posterior margin of dorso- and ventrolateral body plates conspicuously blackened, forming longitudinal zigzag. Longitudinal black stripe along midline of flank fragmented in juvenile specimens. Dorsolateral body plates close to longitudinal stripe on midline of flank unspotted. Dorsal fin covered by irregular black spots; membrane between dorsal spine and first branched dorsal-fin ray with concentration of black chromatophores, generally more concentrated in its dorsal half. Pectoral and pelvic fins unspotted, with concentration of brownish chromatophores on their rays. Anal fin with brown spots; spots aligned forming one to two oblique brown bars in some specimens; first and second anal fin rays markedly blackened in holotype. Adipose fin hyaline with distal margin blackened. Caudal fin with generally three transversal black bars.

Color in life. Very similar to preserved specimens but with ground color of body rosy orange; body covered by greenish yellow iridescent coloration (Fig. 4).

Sexual dimorphism. Additionally to the lanceolate genital papilla in males, which is present in all Corydoradinae (see Nijssen & Isbrücker, 1980; Britto, 2003), the males of *Corydoras knaacki* have an oblong pelvic fin, while in females the pelvic fin is rounded.

Distribution. *Corydoras knaacki* is known from the río Madre de Dios basin, Peru (Fig. 6).



Fig. 4. Color pattern in life of *Corydoras knaacki*, uncatalogued specimen, 37.0 mm SL, collected with the holotype.

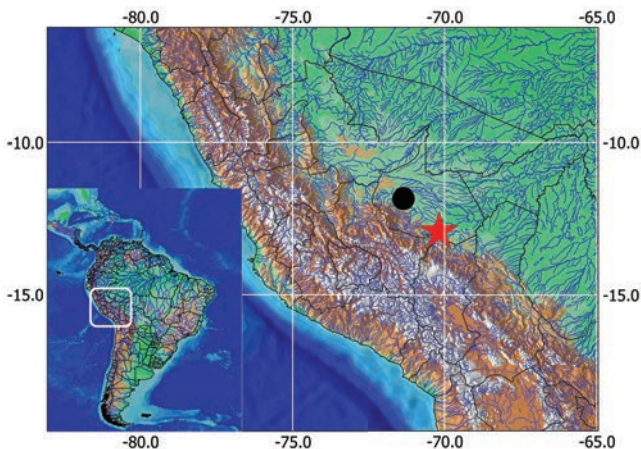


Fig. 5. Geographical distribution of *Corydoras knaacki*. Red star represents type-locality, swamps tributaries to the río Inambari, and the black circle, which includes more than one lot, represents the tributaries to the río Manu, río Madre de Dios basin.

Ecological notes. *Corydoras knaacki* was captured in a swampy area with brownish “tea-colored” stagnant and very clear water. Some congeners, like *Corydoras* aff. *aeneus*, *Corydoras* cf. *elegans* and *Corydoras* cf. *stenocephalus*, were observed in the type-locality of *C. knaacki* (Fig. 7). Additionally, some Characiformes were also observed in syntopy, like *Aphyocharax* sp., *Hoplias* aff. *malabaricus* (Bloch, 1794), *Hyphessobrycon* sp. and *Pyrrhulina vittata*, Regan, 1912.



Fig. 6. Type-locality of *Corydoras knaacki*, showing the swampy area in the vicinity of the town of Santa Rita, draining into the río Inambari, río Madre de Dios basin, Santa Rita, Madre de Dios, Peru.

Juveniles of *Corydoras knaacki*, between 8 up to 15 mm SL, are abundant in the shallow swampy area, forming bigger shoals. Specimens of *Corydoras* aff. *aeneus* with similar size to the specimens of *C. knaacki* were observed mixing in the same shoal with the new species, which is more abundant. Adult specimens of *C. knaacki*, up to 38 mm SL, can be found in small groups only in the deeper parts of the creeks, generally shaded by trees and palms. The adults do not form mixed shoals with *Corydoras* aff. *aeneus*.

Etymology. *Corydoras knaacki* is named after Dr. Joachim Knaack (2 January 1933 – 5 December 2012), German physician and biologist. He was an amateur ichthyologist and aquarist who devoted more than 60 years of his life for the study of South American catfishes, especially *Corydoras*. A genitive noun.

Conservation status. Despite the new species seems to be relatively well distributed in the río Madre de Dios basin, part of its currently known region of occurrence, the río Inambari basin, was recently affected by gold mining and road building. Lujan et al. (2013) demonstrated that the aforementioned threats have already affected the stream community structure of some tributaries to the río Inambari as a whole. However, since there is no available data of the possible direct effects of the gold mining and/or road building in the populations of *C. knaacki*, and also due to the quite plausible possibility that the new species may occurs in other non-affected water bodies of the region, the most reasonable category for *Corydoras knaacki* for the time being, according to the International Union for Conservation of Nature (IUCN) categories and criteria (IUCN Standards and Petitions Subcommittee, 2014), is Least Concern (LC).

Remarks. Corydoradinae catfish are well known in the aquarium hobby and have been collected for the ornamental fish trade for many decades. Many newly encountered species are clearly recognized for being scientifically undescribed. To avoid the creation of *nomina nuda* by using trade names, Evers (1993) suggested to implement a code-system for all undetermined species, giving each species a “C-number” (“C” for “Corydoradinae”) in the German aquarist magazine DATZ (Die Aquarien- und Terrarienzeitschrift). Posteriorly, this system was carried on by the “*Corydoras* World” website (www.corydorasworld.com), and the codes were changed to CW-numbers (“CW” for “*Corydoras* World”). *Corydoras knaacki*, new species, is well known in the aquarium hobby, and has been previously known under the code number CW 032. Corydoradinae species display specific coloration and pigmentation pattern in juveniles, changing pattern during development after hatching onto reaching their adult coloration. *Corydoras knaacki* has been reproduced under aquarium conditions by the second author, and the color pattern of juvenile specimens (with less than 20.0 mm SL) are provided herein (Fig. 7), documenting the unique development of this species during growth.

Discussion

The species with the most similar color pattern to *Corydoras knaacki* are *C. bondi*, from the Yuruari, Corantijn and Rupununi rivers basins (Fig. 8a), *C. sipaliwini*, from coastal rivers basins of Guyana and Suriname (Fig. 8b), and *C. coppenamensis*, from the río Coppename basin (Fig. 8c). Despite the resemblance, the new species can be clearly distinguished from *C. bondi* and *C. sipaliwini* by the presence of conspicuously rounded black spots

on head while in both congeners the spots are irregular, being diffuse in some specimens of *C. bondi*. The relative size of the spots on the snout is also useful to diagnose *C. knaacki* from *C. bondi* and *C. sipaliwini*. In the new species, the spots are moderate in size, contrary to the very small spots of *C. bondi*, and the larger spots of *C. sipaliwini*.

Corydoras knaacki can be clearly distinguished from its most similar congener, *C. coppenamensis*, by the presence of ventral laminar expansion of infraorbital 1 moderately developed (vs. well developed), and also by the anterior expansion of infraorbital 1, which is moderately developed in the new species (Fig. 2a, b), while *C. coppenamensis* displays a very large anterior expansion, conspicuously expanded toward nasal capsule, very similar to what is observed in *C. lymnades* (see Tencatt et al., 2013: 260, fig. 2a). The color pattern of the caudal fin also differs *C. knaacki* from *C. bondi* and *C. coppenamensis* (presence of conspicuous thickened black bars on caudal fin vs. diffuse black spots, not forming well-defined transversal black bars in *C. bondi*; scattered spots forming irregular slender black bars; or diffuse black spots, in *C. coppenamensis*).

An interesting feature observed in the new species is the presence of three unbranched anal-fin rays in some specimens. Generally, *Corydoras* species possess only one or two unbranched rays in anal fin. Another variable feature observed in *C. knaacki* is the contact between infraorbital 2 and compound pterotic in some specimens. Despite of the presence of the contact between infraorbital 2 and compound pterotic, it does not occur in the same way as it does with the other congeners, by means of a triangular or rectangular expansion (Britto, 2003: 129). In the new species, the infraorbital 2 posterior laminar expansion does not possess a secondary expansion in its posterodorsal portion (Fig. 2c, d). The suture between the sphenotic and the compound pterotic seems to determine the presence of contact between infraorbital 2 and compound pterotic (Fig. 2c, d), and not the shape of the infraorbital 2 posterior laminar expansion itself.

Recently, Vera-Alcaraz (2013) conducted the more comprehensive phylogenetic hypothesis for Callichthyidae so far, suggesting the resurrection of some genera to accommodate the species currently attributed to *Corydoras* in order to maintain its monophyly. Among the resurrected genera is *Hoplisoma* Swainson, 1838, which comprises the typical short-snouted species, from the lineages 6, 7 and 9 *sensu* Alexandrou et al. (2011), and also the straight-snouted species from the lineage 8 *sensu* Alexandrou et al. (2011). In Vera-Alcaraz’s (2013) phylogenetic hypothesis, the large clade containing the short- and straight-snouted species is well delimited and clearly does not belong to the *Corydoras* clade, which comprises the typical long-snouted species of the lineage 1 *sensu* Alexandrou et al. (2011). *Corydoras knaacki* is a typical short-snouted species that clearly fits within the *Hoplisoma* clade *sensu* Vera-Alcaraz (2013). However, since the phylogenetic hypothesis conducted by Vera-Alcaraz (2013) is still unpublished, the new species will be regarded as *Corydoras* until formal publication of any generic revision derived from Vera-Alcaraz’s work.

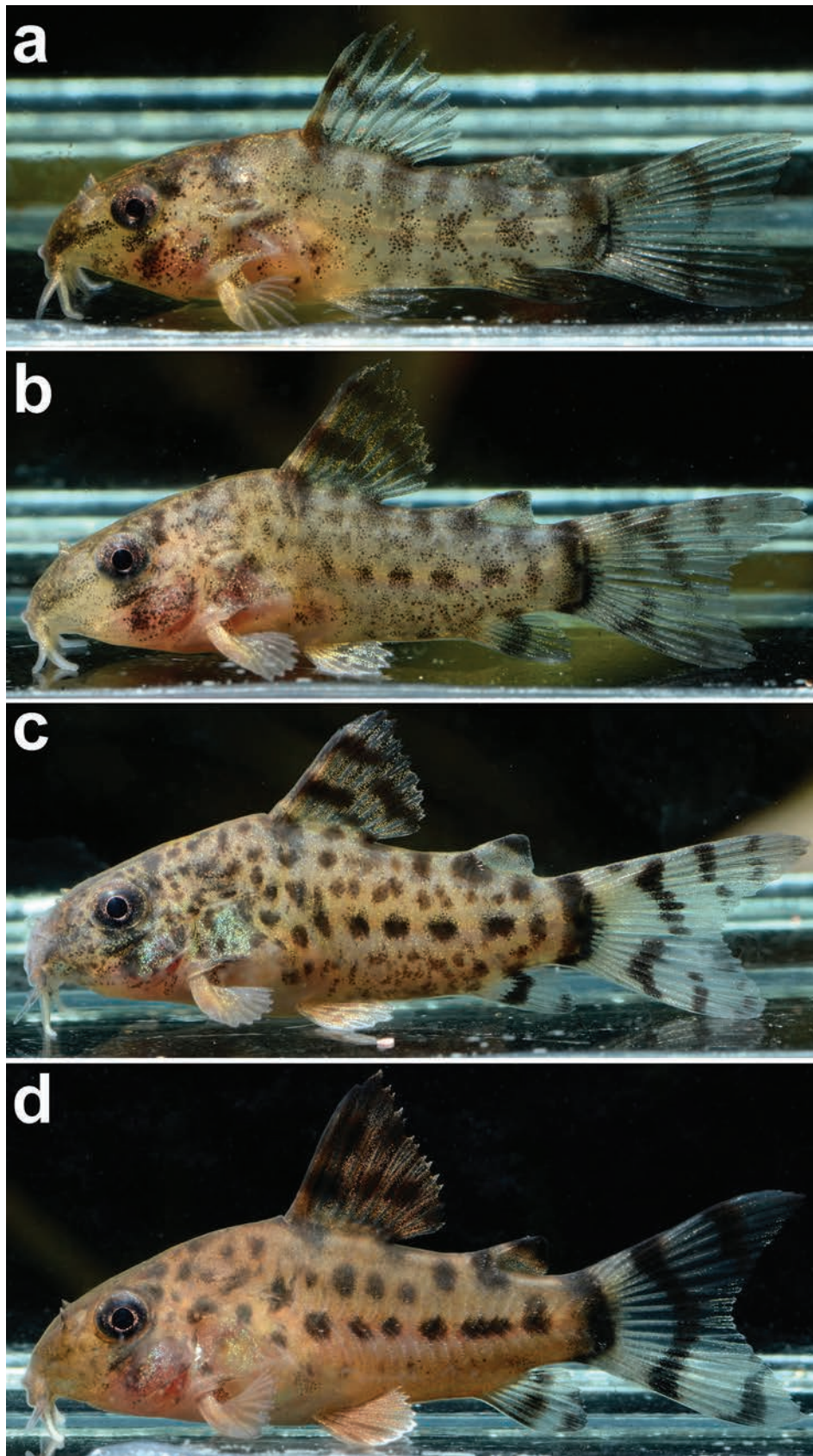


Fig. 7. Ontogenetic development of the color pattern in *Corydoras knaacki*, showing uncatalogued specimens with (a) 10.0 mm SL, (b) 14.0 mm SL, (c) 16.0 mm SL, and (d) 19.0 mm SL. Juveniles in the first six weeks show these typical color patterns until the coloration turns into the adult pattern with a size of 20 mm onwards.

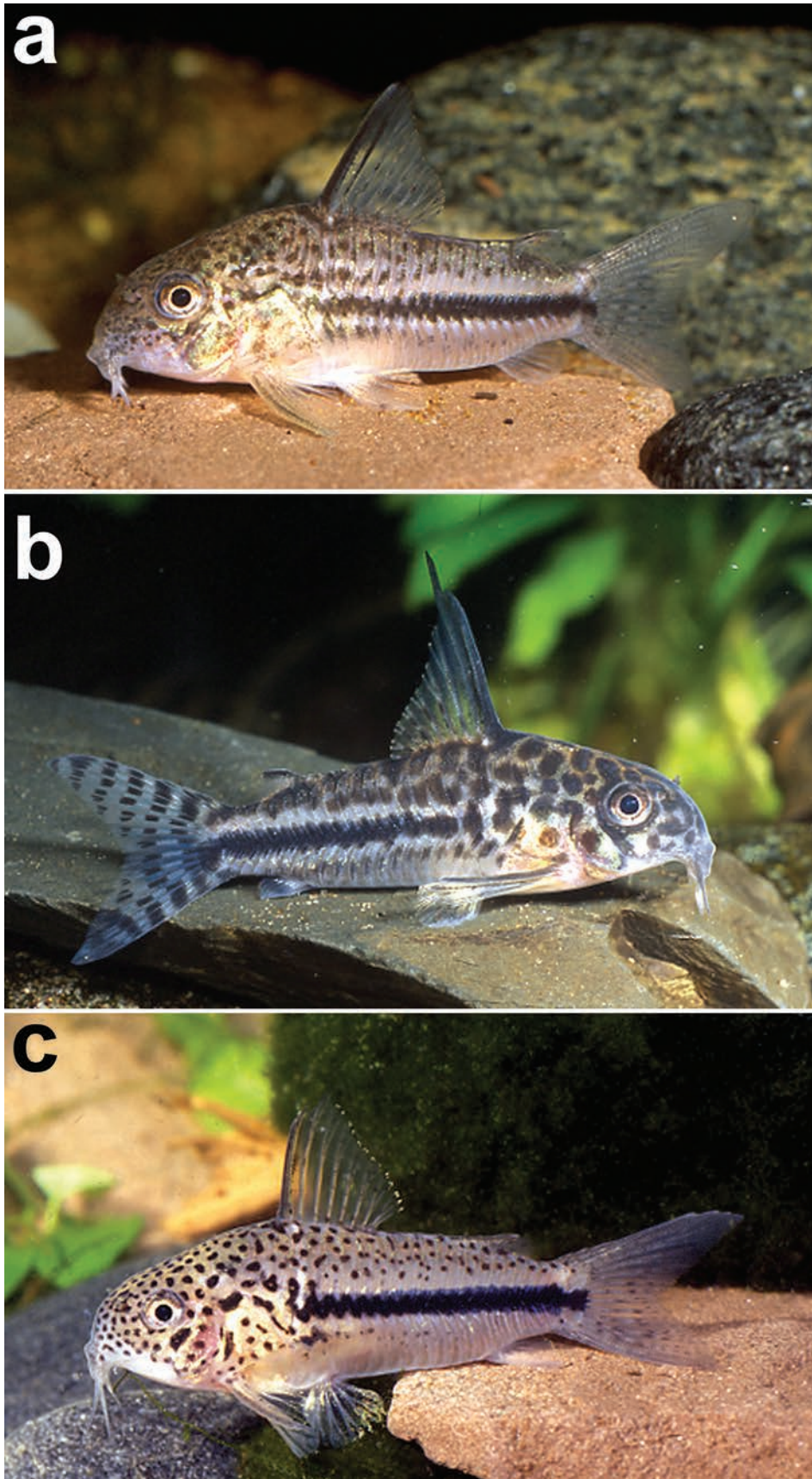


Fig. 8. Color pattern in life of uncatalogued aquarium specimens of (a) *Corydoras bondi*, (b) *Corydoras sipaliwini*, and (c) *Corydoras coppenamensis*.

Comparative material examined. *Corydoras acutus*: **Peru**: Unknown department. MNRJ 3985, 2, 47.1-54.8 mm SL, Sansho-Caño. *Corydoras adolfoi*: **Brazil**: Amazonas. LBP 6863, 2, 27.5-31.7 mm SL, Igarapé Puranga. LBP 6871, 2, 32.2-32.5 mm SL, unnamed Igarapé. *Corydoras ambiacus*: **Peru**: Loreto. MCP 26178, 1, 42.5 mm SL, rio Pacaya; MCP 26209, 10 of 19, 25.0-33.3 mm SL, Caño Yarina. Ucayali. MZUSP 26053, 2, 41.8-47.2 mm SL, Iamiriacochoa. *Corydoras approuaguensis*: **French Guyana**: Cayenne. MZUSP 27895-6, 2, 43.0-46.1 mm SL, paratypes of *Corydoras approuaguensis* Nijssen & Isbrücker, 1983, rio Approuague. *Corydoras araguaiaensis*: **Brazil**: Mato Grosso. MZUSP 87155, 4 of 33, 24.9-46.7 mm SL, 2 c&s, 27.6-31.8 mm SL, Corixo da Saudade. *Corydoras areio*: **Brazil**: Mato Grosso do Sul. ZUFMS-PIS 1314, 15, 34.4-41.9 mm SL, 2 c&s, 38.1-38.5 mm SL, Periquito stream. *Corydoras aurofrenatus*: **Paraguay**: Concepción. NRM 23529, 10 of 33, 31.4-45.7 mm SL, Arroyo Laguna Penayo where it crosses the road Concepción-Paso Barreto. *Corydoras bifasciatus*: **Brazil**: Pará. MZUSP 38976, 16, paratypes, 23.6-30.0 mm SL, creek at left bank of the rio Cururu. *Corydoras blochi*: **Brazil**: Roraima. MZUSP 8580, 3, 31.0-42.6 mm SL, paratypes of *Corydoras blochi* Nijssen, 1971, Igarapé on Fazenda Canadá, tributary to the rio Uraricoera. *Corydoras bondi*: **Guyana**: Barima-Waini. ROM 66202, 7 of 134, 33.8-39.9 mm SL, 3 c&s of 134, 36.7-38.6 mm SL, Waikerebi Creek. *Corydoras brevirostris*: **Venezuela**: Bolívar. LBP 3080, 10, 23.8-27.7 mm SL, 3 c&s, 25.8-27.9 mm SL, rio Orinoco. *Corydoras britskii*: **Brazil**: Mato Grosso do Sul. ZUFMS-PIS 862, 12, 72.0-78.0 mm SL, marginal lagoon to rio Vermelho. *Corydoras carlae*: **Brazil**: Paraná. NUP 711, 1, 47.9 mm SL, rio Tormenta; NUP 4425, 1 c&s, 45.0 mm SL, rio Tormenta. *Corydoras cochui*: **Brazil**: Goiás. MZUSP 89055, 6, 18.7-23.6 mm SL, rio do Peixe II. Tocantins. MZUSP 35838, 4 of 6, 16.1-18.5 mm SL, rio Javaés. *Corydoras condiscipulus*: **French Guyana**: Cayenne. MZUSP 38957, 7, 34.1-40.3 mm SL, paratypes of *Corydoras condiscipulus* Nijssen & Isbrücker, 1980, Cumuri Creek. *Corydoras crimmeni*: **Brazil**: Uncertain state. MZUSP 52490, 1, 36.1 mm SL, holotype of *Corydoras crimmeni* Grant, 1998, aquarium specimens said to be from near the town of Boa Vista, Roraima, possibly from the rio Branco. *Corydoras davidsandsi*: **Brazil**: Amazonas. MZUSP 110066, 4 of 40, 36.0-41.9 mm SL, 2 c&s of 40, 40.9-42.1 mm SL, rio Inambú. *Corydoras difluviatilis*: **Brazil**: São Paulo. MZUSP 75268, 1, 39.8 mm SL, holotype of *Corydoras difluviatilis* Britto & Castro, 2002, Paulicéia stream. *Corydoras diphyes*: **Paraguay**: Alto Paraná. ANSP 169756, 2, 40.7-43.1 mm SL, drainage ditches north of km 250 (2 km east of Juan E. O'Leary on route 7). *Corydoras ehrhardti*: **Brazil**: Paraná. NUP 11255, 15, 36.5-46.8 mm SL, rio São Pedro. *Corydoras elegans*: **Peru**: Ucayali. MZUSP 26017, 6, 25.9-28.3 mm SL, Lobococha. *Corydoras ephippifer*: **Brazil**: Amapá. MZUSP 31605, 2, 44.9-49.1 mm SL, rio Cupixi. *Corydoras eques*: **Brazil**: Amazonas. MCZ 8204, 4 of 12, 37.6-44.4 mm SL, paratypes of *Corydoras eques* Steindachner, 1876, rio Amazonas at Codajás. *Corydoras flaveolus*: **Brazil**: São Paulo. MZUSP 424, 1, 33.4 mm SL, holotype of *Corydoras flaveolus* Ihering, 1911, tributaries to the rio Piracicaba. *Corydoras fowleri*: **Peru**: Loreto. LBP 12462, 9, 44.3-59.9 mm SL, 1 c&s, 50.4 mm SL, tributary to the rio Ampiyacu. *Corydoras garbei*: **Brazil**: Minas Gerais. MNRJ 18089, 14, 19.2-25.3 mm SL, 2 c&s, 25.9-27.4 mm SL, Perta-Pé lagoon. *Corydoras gossei*: **Brazil**: Rondônia. MZUSP 38977, 6, 48.4-53.4 mm SL, paratypes of *Corydoras gossei* Nijssen, 1972, Igarapé do 13, tributary to the rio Mamoré. *Corydoras griseus*: **Guyana**: Potaro-Siparuni. MZUSP 108896, 4 of 13, 31.5-36.2 mm SL, 2 c&s of 13, 30.6-34.5 mm SL, Igarapé tributary to the rio Kuribrong. *Corydoras gryphus*: **Brazil**: Paraná. MNRJ 40770, 1, 32.3 mm SL, holotype of *Corydoras gryphus* Tencatt, Britto & Pavanelli, 2014, rio Paraná (near Ponte da Amizade). NUP 14676, 3 c&s, 27.7-32.4 mm SL, paratypes of *Corydoras gryphus* Tencatt, Britto & Pavanelli, 2014, rio Paraná (near Ponte da Amizade). *Corydoras guapore*: **Brazil**: Mato Grosso. ZUFMS-PIS 4000, 5, 26.9-33.6 mm SL, 2 c&s, 28.8-29.2 mm SL, rio Guaporé. *Corydoras hastatus*: **Brazil**: Mato Grosso. NUP 6862, 116, 13.1-20.7 mm SL, baía Caiçara. *Corydoras incolicana*: **Brazil**: Amazonas. MZUSP 45717, 1, 47.6 mm SL, holotype of *Corydoras incolicana* Burgess, 1993, rio Içana. *Corydoras julii*: **Brazil**: Piauí. NUP 16225, 1, 46.8 mm SL, rio Atalaia. *Corydoras kanei*: **Brazil**: Uncertain state. MZUSP 52489, 1, 36.6 mm SL, holotype of *Corydoras kanei* Grant, 1998, aquarium specimens said to be from near the town of Boa Vista, Roraima, possibly from the rio Branco. *Corydoras lacrimostigmata*: **Brazil**: Paraná. MNRJ 40725, 1, 31.8 mm SL, holotype of *Corydoras lacrimostigmata* Tencatt, Britto & Pavanelli, 2014, rio Maria Flora; NUP 14657, 3 c&s, 30.9-34.5 mm SL paratypes of *Corydoras lacrimostigmata* Tencatt, Britto & Pavanelli, 2014, rio Nestor. *Corydoras longipinnis*: **Argentina**. Santiago del Estero: AI 221, 1, 59.5 mm SL, holotype of *Corydoras longipinnis* Knaack, 2007, rio Sali. Tucumán: NUP 14440, 2 c&s, 29.9-33.4 mm SL, Pampa-Mayo stream. *Corydoras lymnades*: **Brazil**: Minas Gerais. MNRJ 15765, 6, 15.8-17.7 mm SL, 2 c&s, 18.1-18.4 mm SL, rio Peruaçu; MNRJ 40186, 1, 29.7 mm SL, holotype of *Corydoras lymnades* Tencatt, Vera-Alcaraz, Britto & Pavanelli, 2013, rio Guarda-Mor. *Corydoras maculifer*: **Brazil**: Tocantins. NUP 8970, 2, 42.0-46.0 mm SL, ribeirão Xambioazinho. *Corydoras melanistius*: **Guyana**: Unknown region. BMNH 1864.1.21.86, 1, 35.0 mm SL, lectotype of *Corydoras melanistius* Regan, 1912, designated by Nijssen & Isbrücker, 1967, rio Essequibo. *Corydoras multimaculatus*: **Brazil**: Minas Gerais. MCP 29025, 2, 20.1-25.4 mm SL, rio Peruaçu. *Corydoras nattereri*: **Brazil**: São Paulo. MZUSP 110255, 4 of 31, 32.0-32.8 mm SL, 2 c&s of 31, 32.3-34.4 mm SL, rio Paraitinga. *Corydoras paleatus*: **Uruguay**. Canelones. NRM 54230, 1, 53.5 mm SL, Sarandí stream. *Corydoras panda*: **Peru**: Huánuco. ROM 55815, 6, 26.5-39.7 mm SL, unknown stream somewhere above Panguana in Llullapichis drainage. *Corydoras pantanalensis*: **Brazil**: Mato Grosso. NUP 10188, 1 c&s, 46.4 mm SL, Baía Sinhá Mariana. Mato Grosso do Sul. NUP 12593, 21, 38.7-51.2 mm SL, tributary to the rio Miranda. *Corydoras parallelus*: **Brazil**: Amazonas. MZUSP 45716, 1, 47.4 mm SL, holotype of *Corydoras parallelus* Burgess, 1993, rio Içana. *Corydoras pinheiroi*: **Brazil**: Rondônia. MZUSP 48099, 1, 54.3 mm SL, holotype of *Corydoras pinheiroi* Dinkelmeyer, 1995, stream tributary to the rio Ribeiro, at Guajará-Mirim. *Corydoras potaroensis*: **Guyana**: Potaro-Siparuni. ROM 61526, 3 of 15, 35.0-44.8 mm SL, 2 c&s of 15, 32.6-35.1 mm SL, rio Potaro. *Corydoras robineae*: **Brazil**:

Amazonas. MZUSP 27175, 1, 33.7 mm SL, holotype of *Corydoras robineae* Burgess, 1983, rio Aiuaana. *Corydoras sarareensis*: **Brazil**: Mato Grosso. MZUSP 48100, 1, 40.9 mm SL, holotype of *Corydoras sarareensis* Dinkelmeyer, 1995, rio Sararé. *Corydoras seussi*: **Brazil**: Rondônia. MZUSP 49323, 10, 44.3-54.0 mm SL, paratypes of *Corydoras seussi* Dinkelmeyer, 1996, small stream tributary to the rio Pacas-Novos (= Pacaás Novos), near Guajará-Mirim. *Corydoras similis*: **Brazil**: Acre. LBP 10648, 7, 21.4-34.3 mm SL, rio Iquiri. *Corydoras splendens*: **Brazil**: Goiás. NUP 12990, 1, 43.7 mm SL, tributary to the rio Araguaia. Mato Grosso. NUP 10195, 1 c&s, 54.6 mm SL, Pai Caetano lake. *Corydoras stenocephalus*: **Brazil**: Amazonas. MNRJ 3625, 3, 31.2-62.3 mm SL, rio Javari. *Corydoras treitlii*: **Brazil**: Maranhão. NUP 16224, 3, 21.5-45.6 mm SL, rio Medonho. *Corydoras trilineatus*: **Brazil**: Acre. MZUSP 30857, 3 of 25, 40.9-44.1 mm SL, 2 c&s of 25, 44.2-43.8 mm SL, rio Tarauacá. *Corydoras tukano*: **Brazil**: Amazonas. MZUSP 82100, 40.9 mm SL, holotype of *Corydoras tukano* Britto & Lima, 2003, rio Tiquié. *Corydoras zygatus*: **Brazil**: Acre. MZUSP 30858, 4 of 15, 41.7-47.3 mm SL, rio Tarauacá.

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