Neotropical Ichthyology

Original article https://doi.org/10.1590/1982-0224-2021-0119

urn:lsid:zoobank.org:pub:75800B1A-D828-4801-8AC5-C5CA22484B2D

The emerald green tetra: a new restricted-range *Hyphessobrycon* (Characiformes: Characidae) from the upper rio Juruena, Chapada dos Parecis, Brazil

Correspondence:
Fernando Cesar Paiva Dagosta
ferdagosta@gmail.com

Fernando Cesar Paiva Dagosta[1], Thomaz Jefrey Seren[1],
Anderson Ferreira[1] and Manoela Maria Ferreira Marinho[2]

Submitted July 24, 2021
Accepted December 3, 2021
by Marcos Mirande
Epub March 28, 2022

A new species of *Hyphessobrycon* is described from the rio Mutum, a tributary of the rio Juruena, rio Tapajós basin, Brazil. The new taxon can be distinguished from its congeners by the presence of a well-defined and relatively narrow dark midlateral stripe on body, extending from head to the middle caudal-fin rays, presence of a humeral blotch, distal profile of the anal fin falcate in males, 13–16 branched anal-fin rays (*vs.* 17–26), and 11 or 12 horizontal scale rows around caudal peduncle. The new species shows polymorphism regarding the presence of the adipose fin, and a discussion on this type of polymorphism across the family and its systematic implications is presented.

Keywords: Adipose fin, Amazon, *Hyphessobrycon melanostichos*, Tapajós, Taxonomy.

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

Neotrop. Ichthyol.

vol. 20, no. 1, Maringá 2022

---

1 Faculdade de Ciências Biológicas e Ambientais, Universidade Federal da Grande Dourados, Rodovia Dourados/Itahum, km 12, 79804–970 Dourados, MS, Brazil. (FCPD) ferdagosta@gmail.com (corresponding author), (TJS) thomazjefrey@gmail.com, (AF) andersonferreira@ufgd.edu.br.

2 Departamento de Sistemática e Ecologia, Universidade Federal da Paraíba, Cidade Universitária, s/n, Castelo Branco, 58033–455 João Pessoa, PB, Brazil. manoela.marinho@gmail.com.

Uma espécie nova de *Hyphessobrycon* é descrita do rio Mutum, um afluente do rio Juruena, bacia do rio Tapajós, Brasil. O táxon novo pode ser distinguido de seus congêneres pela presença de uma faixa média-lateral escura bem definida e relativamente estreita no corpo, estendendo-se da cabeça aos raios médios da nadadeira caudal, presença de uma mancha umeral, 13–16 raios da nadadeira anal ramificada (*vs.* 17–26) e 11–12 séries horizontais de escamas ao redor do pedúnculo caudal. A espécie nova apresenta polimorfismo em relação à presença da nadadeira adiposa. Assim, é apresentada uma discussão sobre esse tipo de polimorfismo em toda a família e suas implicações na sistemática do grupo.

Palavras-chave: Amazonas, *Hyphessobrycon melanostichos*, Nadadeira adiposa, Tapajós, Taxonomia.

INTRODUCTION

Hyphessobrycon Durbin, 1908 is one of the most species-rich genera of the Characidae, currently with more than 160 valid species (Marinho *et al*., 2016; Carvalho *et al*., 2017; Pastana *et al*., 2017; Faria *et al*., 2020; Fricke *et al*., 2022). It is distributed from southern Mexico to the rio de La Plata in Argentina, but most species occur in the Cis-Andean region, mainly in the Amazon basin, where it is the second most rich genus (Dagosta, de Pinna, 2019). Besides being diverse in the number of species and in body shape diversity, the group is also plenty in color variation. It ranges from the flame-colored rosy-tetra clade to the elegant *Hyphessobrycon loweae*-group (*sensu* Ingenito *et al*., 2013), with elongate fins, or to the contrasting colored, dark banded species such as the *Hyphessobrycon heterorhabdus* species-group (*sensu* Faria *et al*., 2021).

A new species was collected during an expedition to the headwaters of the upper rio Juruena, rio Tapajós basin, at Chapada dos Parecis, Brazil. The new species is remarkable in coloration and has been exported by aquarists under the name *Hyphessobrycon melanostichos* Carvalho & Bertaco, 2006. It is popularly known as 'emerald green tetra'. Additional specimens were recognized in the MZUSP collection and examined. The objective of the present work is to describe the new species and to evaluate its conservation status. Because the new taxon is polymorphic regarding the presence of adipose fin, we also discuss the application of this character in the systematic of characids.

MATERIAL AND METHODS

Counts and measurements follow Fink, Weitzman (1974), except for not including eye-dorsal fin origin measurement and for number of horizontal scale rows below lateral line, which are counted to the pelvic-fin insertion, not including the small scale at pelvic-fin insertion, and with the addition of head depth, measured at vertical through the base of supraoccipital process. Standard length (SL) is given in millimeters (mm) and all other measurements are expressed as percentage of SL or of head length (HL) for subunits of head. In the description, counts are followed by their frequency of occurrence in parentheses, and an asterisk indicates the counts of the holotype. Number of maxillary tooth cusps, small dentary teeth, supraneurals, branchiostegal rays, gill rakers, vertebrae, unbranched anal-fin rays, and procurrent caudal-fin rays were obtained only from cleared and stained (c&s) specimens prepared according to Taylor, Van Dyke (1985). Vertebrae of the Weberian apparatus are counted as four elements and the compound caudal centra (PU1+U1) as a single element. *Circuli* and *radii* counts were taken from scale row immediately above the lateral line. The sex of specimens was confirmed by dissection and direct examination of the gonads. Diet was checked in 20 individuals from the type locality (22.3–35.0 mm SL). In the list of types and comparative material, catalog numbers are followed by the number of specimens in alcohol, their SL range, and if any, the number of c&s specimens and their respective SL range. Institutional abbreviations follow Sabaj (2020).

RESULTS

Hyphessobrycon comodoro, new species

urn:lsid:zoobank.org:act:2F8D142C-C2D3-4CB2-AD15-D746BB4F90E4

(Figs. 1–2; Tab. 1)

Holotype. MZUSP 125904, 29.6 mm SL. Brazil, Mato Grosso State, Municipality of Comodoro, lagoon at tributary of the rio Mutum, formed due to the construction of a road, tributary of rio Camararé, upper rio Juruena basin, rio Tapajós basin, 13°12'47.6"S 59°54'13.8"W, 567 m a.s.l., 19 Oct 2018, F. Dagosta, A. Ferreira & H. Lenza.

Paratypes. All from Brazil, Mato Grosso State, Municipality of Comodoro, rio Mutum drainage, upper rio Juruena basin. MZUSP 125215, 4 c&s, 211, 16.8–38.6 mm SL, UFPB 12086, 10, 24.0–31.2 mm SL, INPA 59651, 5, 26.2–31.1 mm SL, collected with holotype. MZUSP 115698, 22, 18.2–34.0 mm SL, rio Mutum at the Fazenda Mutum, at the bridge of the road between Comodoro and Vilhena, 13°05'09.2"S 59°53'33.8"W, 502 m a.s.l., 29 Aug 2013, O. Oyakawa, F. Dagosta, M. Marinho & P. Camelier. MZUSP 125217, 63, 13.9–32.1 mm SL, lagoon at tributary of the rio Mutum, formed due to the construction of a road, tributary of rio Camararé, upper rio Juruena basin, rio Tapajós basin, 13°13'23.2"S 59°54'41.8"W, 551 m a.s.l., 19 Oct 2018, F. Dagosta, A. Ferreira & H. Lenza. MZUSP 125221, 136, 14.3–29.7 mm SL, rio Mutum at the bridge of the road BR–364, 13°05'05.3"S 59°53'30.7"W, 504 m a.s.l., 20 Oct 2018, F. Dagosta, A. Ferreira & H. Lenza.

Diagnose. The new species can be distinguished from all congeners, except *Hyphessobrycon. cachimbensis* Travassos, 1964, *H. cyanotaenia* Zarske & Géry, 2006, *H. fernandezi* Fernández-Yépez, 1972, *H. melanostichos*, *H. nigricinctus* Zarske & Géry, 2004, *H. paucilepis* García-Alzate, Román-Valencia & Taphorn, 2008, *H. petricolus* Ohara, Lima & Barros, 2017, *H. piranga* Camelier, Dagosta & Marinho, 2018, *H. psittacus* Dagosta, Marinho, Camelier & Lima, 2016, *H. scholzei* Ahl, 1937, *H. sovichthys* Schultz, 1944, *H. stegemanni* Géry, 1961, *H. taphorni* García-Alzate, Román-Valencia & Ortega, 2013, *H. tuyensis* García-Alzate, Román-Valencia & Taphorn, 2008, and *H. vilmae* Géry, 1966 by the presence of a well-defined and relatively narrow dark midlateral stripe on body, extending from head to the middle caudal-fin rays (*vs.* well-defined longitudinal stripe absent, or stripe wider than the orbit, or stripe starting approximately vertically through the origin of the dorsal fin or stripe blurred posteriorly). The new species is distinguished from the aforementioned species, except *H. cachimbensis*, *H. cyanotaenia*, *H. melanostichos*, *H. nigricinctus*, and *H. petricolus*, by the possession of a humeral blotch (*vs.* humeral blotch absent). It is distinguished from *H. cachimbensis* and *H. cyanotaenia* by having the distal profile of the anal fin falcate in males (*vs.* approximately straight or convex) and from *H. cachimbensis*, *H. petricolus*, and *H. nigricinctus* by having 13–16 branched anal-fin rays (*vs.* 17–26). It can be further distinguished from *H. cyanotaenia* by lacking concentration of black pigmentation on longest rays of dorsal, pelvic, and anal fins (*vs.* pigmentation present). It is readily distinguished from *H. melanostichos*, the most similar congener, by having 11 or 12 horizontal scale rows around caudal

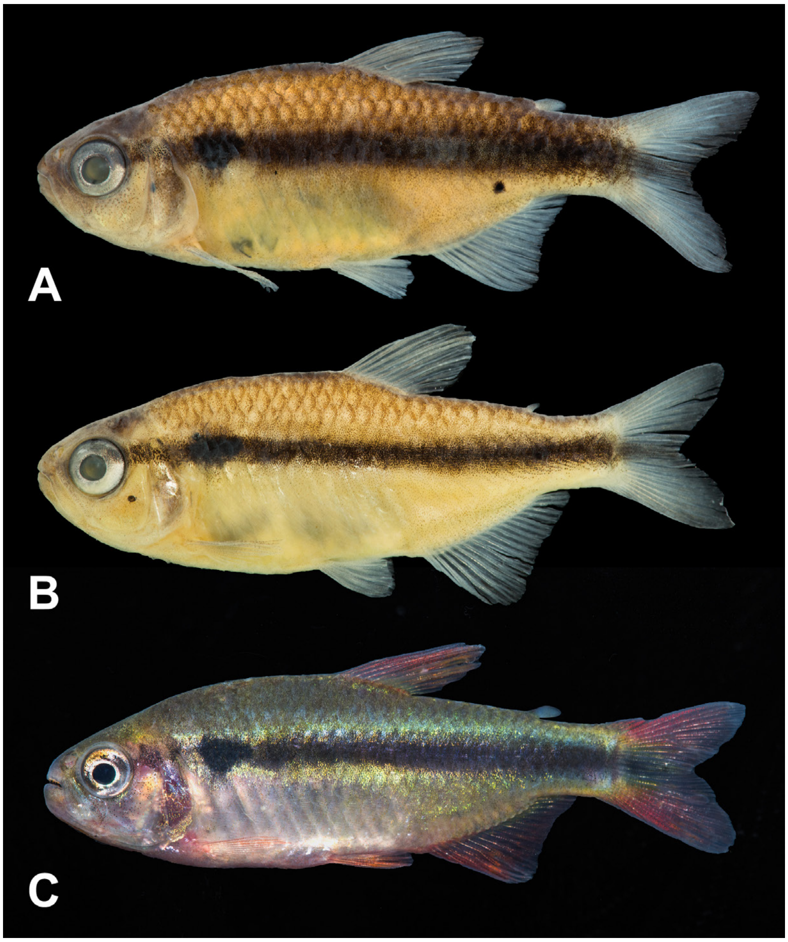

FIGURE 1 | *Hyphessobrycon comodoro*, Brazil, Mato Grosso State, Municipality of Comodoro, rio Mutum, upper rio Juruena basin: **A.** Holotype, MZUSP 125904, 29.6 mm SL, male; **B.** Paratype, MZUSP 125215, 25.3 mm SL, female; **C.** Aquarium specimen, not measured or preserved.

peduncle (*vs.* 14), fewer branched pelvic-fin rays (6 *vs.* 7), humeral blotch wider than deep, with pigmentation much more intense than the dark midlateral band, with well-defined edges (*vs.* humeral blotch deeper than wide, with pigmentation similar to the dark midlateral band, without well-defined edges). Another useful character in distinguishing *H. comodoro* from *H. melanostichos* is the presence of 13–15, mode 14, rarely 16 (only 3 of 30 specimens), branched anal-fin rays (*vs.* 16–18, mode 16).

Description. Morphometric data in Tab. 1. Body compressed, moderately elongate. Greatest body depth at dorsal-fin origin. Dorsal profile of head convex from upper lip to vertical through posterior nostril; slightly convex from that point to base of supraoccipital spine Dorsal profile of body convex along predorsal region, slightly convex along dorsal-fin base, straight from terminus of dorsal-fin base to adipose-fin origin, and slightly concave to straight from that point to origin of anteriormost dorsal procurrent caudal-fin ray. Ventral profile of head and body convex from tip of lower lip to pelvic-fin origin, slightly concave between latter point to anal-fin origin, somewhat straight to convex (see Sexual Dimorphism section) along anal-fin base, and concave from the terminus of anal fin to origin of anteriormost ventral procurrent caudal-fin ray.

Jaws vertically aligned, mouth terminal. Premaxillary teeth in two distinct rows. Outer row with 2(1), 3*(21), or 4(9) tri- to pentacuspid teeth. Inner row with 5*(31) tri- to heptacuspid teeth. Posterior tip of maxilla at vertical through posterior half of second infraorbital. Maxilla with 1(2), 2*(28), or 3(1) conical to pentacuspid teeth. Dentary

TABLE 1 | Morphometric data of *Hyphessobrycon comodoro*. Range includes the holotype. SD = Standard deviation.

	Holotype	n	Range	Mean	SD
Standard length (mm)	29.6	30	20.7–35	28.2	–
Percentage of standard length					
Depth at dorsal-fin origin	36.3	30	30.6–37.9	34.4	1.8
Snout to dorsal-fin origin	54.2	30	53–57.7	55.6	1.1
Snout to pectoral-fin origin	28.5	30	27.4–31.5	29.3	1.1
Snout to pelvic-fin origin	52.8	30	49.5–56.3	52.8	1.5
Snout to anal-fin origin	70.0	30	66.8–74.2	70.4	1.7
Caudal-peduncle depth	13.6	30	10.5–13.7	12.5	0.7
Caudal-peduncle length	13.8	30	10.2–15	12.3	1.2
Pectoral-fin length	19.2	30	17.7–20.9	19.2	0.8
Pelvic-fin length	15.8	30	14.3–19	15.8	0.9
Dorsal-fin length	27.7	30	21.9–27.7	25.8	1.4
Dorsal-fin base length	14.0	30	11.7–16	13.6	1.1
Anal-fin length	20.3	30	17.2–22.3	20.0	1.3
Anal-fin base length	22.2	30	19.4–26.1	22.0	1.6
Head length	29.6	30	27.1–32	29.1	1.1
Percentage of head length					
Horizontal eye diameter	34.8	30	30.6–41.1	36.2	2.3
Snout length	20.6	30	40.5–49.1	22.9	1.5
Interorbital width	26.2	30	20.5–31.7	27.2	1.8
Upper jaw length	41.1	30	24.4–25.9	44.8	1.9

with 5*(31) larger penta- to heptacuspid teeth followed by series of 5 to 9 diminutive conical to tricuspid teeth. Central median cusp in all teeth longer than lateral cusps. Branchiostegal rays 4(4). Gill-rakers 8(2) or 9(2) in the lower and 7(1) or 8(3) in the upper branch.

Cycloid scales, with 5–7 radii from focus to posterior border, and conspicuous *circulii* anteriorly. Lateral line incomplete, with 6(1), 7(1), 8*(26), 9(2), or 10(1) perforated scales, and 29*(6), 30(16), or 31(7) total scales on longitudinal series. Longitudinal scale rows between dorsal-fin origin and lateral line 4(1) or 5*(30). Longitudinal scale rows between lateral line and pelvic-fin origin 3*(27) or 4(4). Scales along middorsal line between posterior tip of supraoccipital process and dorsal-fin origin 9*(13), 10(11), or 11(7). Horizontal scale rows around caudal peduncle 11(6) or 12*(25). Base of anteriormost anal-fin rays covered by series of 3 or 4 scales. Caudal fin not scaled.

Supraneurals 4(2) or 5(2). Dorsal-fin rays ii*(29), iii(2), 7(1), 8(10), or 9*(20). Base of last dorsal-fin ray at vertical anterior to anal fin. Pectoral-fin rays i*(31), 9(16), or 10*(15). Pelvic-fin rays i*(31), 6*(31). Adipose fin frequently present, of variable size, present in 27 specimens, absent in four specimens. Anal fin falcate, with iv*(4), 13(3), 14*(18), 15(7), or 16(3) branched rays. Principal caudal-fin rays i,9,8,i*(27), i,8,8,i(1), i,10,8,i(1), i,9,7,i(1); caudal fin forked, lobes somewhat pointed, of similar size. Dorsal procurrent caudal-fin rays 10(4); ventral procurrent caudal-fin rays 9(4). Total vertebrae 32(2) or 33(2): precaudal vertebrae 14(1) or 15(3) and caudal vertebrae 17(2) or 18(2).

Color in alcohol. Overall ground coloration of head and body beige (Fig. 1). Some specimens retaining guanine on opercular region. Dorsal portion of head and dorsal midline of body dark. A reticulated pattern on first three to four horizontal scale rows, formed by concentration of chromatophores on posterior margin of scales. Snout, jaws and 1st and 2nd infraorbitals with concentration of dark chromatophores, 3rd and 4th infraorbitals with scattered dark pigmentation and 5th and 6th infraorbitals densely pigmented with dark chromatophores, continuing with dark midlateral stripe. Roughly inverted teardrop-shaped humeral blotch formed by two layers of pigmentation. Superficial layer darker and conspicuous, overlapping midlateral stripe and encompassing approximately four scales horizontally and one or two vertically. Subjacent layer with scattered pigmentation encompassing approximately three scales vertically and forming a ventral projection to the humeral spot with diffuse borders. Dark midlateral stripe on body, extending from upper half of posterior portion of eye to tip of middle caudal-fin rays. Abdominal region with few scattered chromatophores. Sparse dark chromatophores above anal fin, mainly near anal-fin base. Caudal-peduncle blotch absent. Adipose fin with scattered dark chromatophores. All fins with dark chromatophores scattered along edge of lepidotrichia. Dorsal and anal fins with dark pigmentation on interadial membranes. Some specimens with sparse dark pigmentation on pelvic-fin interadial membranes.

Color in life. Middorsal area olive green (Figs. 1C, 2); abdominal region silvery to yellow, with some specimens with orange pigmentation in the ventral portion. Upper portion of eye yellow to red, upper-posterior region dark pigmented. First and second infraorbitals, maxilla, lower jaw, gular area and preopercle with yellow pigmentation and scattered orange chromatophores. Remaining infraorbitals mostly silvery and with sparse orange cromatophores. Some specimens with lower portion of opercle lacking guanine, exposing red branchial filaments inside branchial chamber. Bright green midlateral stripe above and below the dark midlateral stripe, thicker at region above anal-fin base. All fins vivid orange to red coloration, more intense in caudal and anal fins. Adipose fin pale hyaline to pale yellow.

Sexual dimorphism. Males with anal-fin base slightly convex (*vs.* somewhat straight in females). Dark midlateral stripe in males wider and blurred (*vs.* midlateral stripe relatively narrow and with more defined edges in females), a type of sexual dichromatism involving the larger concentration of melanophore-based pigments in males (Pastana *et al.*, 2017). Bony hooks on fins not present.

Geographical distribution. The new species is so far known from headwater of the rio Mutum, tributary of the rio Camararé, upper rio Juruena basin at Chapada dos Parecis, Mato Grosso State, Brazil (Fig. 3).

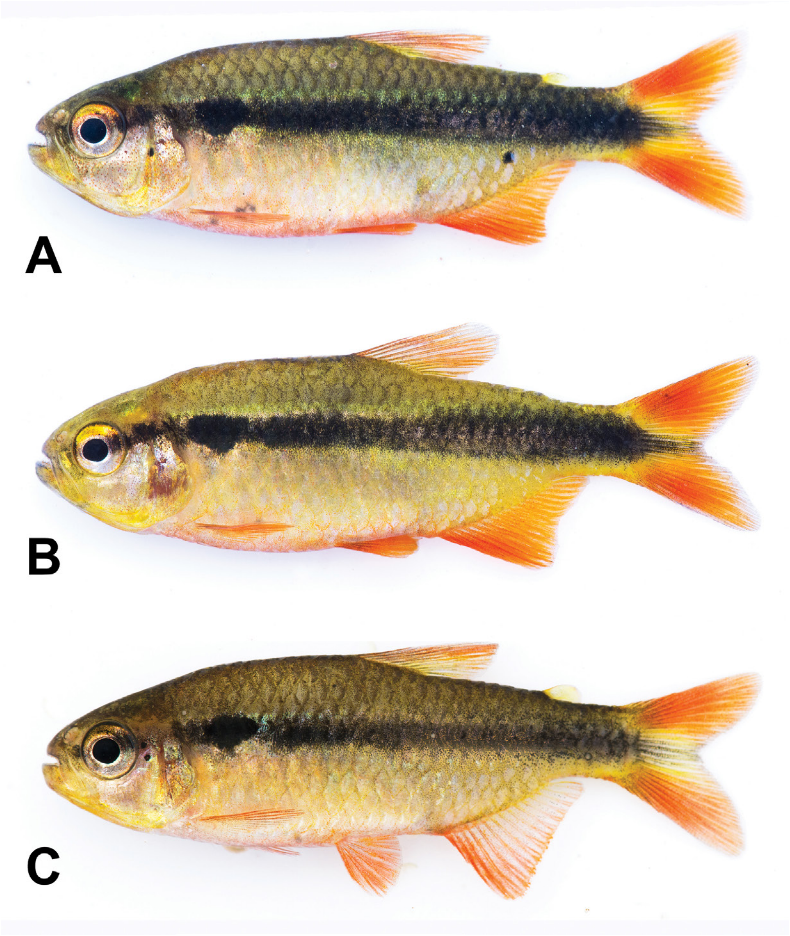

FIGURE 2 | Live coloration of *Hyphessobrycon comodoro*, Brazil, Mato Grosso State, Municipality of Comodoro, rio Mutum, upper rio Juruena basin: **A.** Holotype, MZUSP 125904, 29.6 mm SL, male; **B.** Paratype, MZUSP 125215, 27.4 mm SL, male lacking adipose fin; **C.** Paratype, MZUSP 125215, 29.8 mm SL, female.

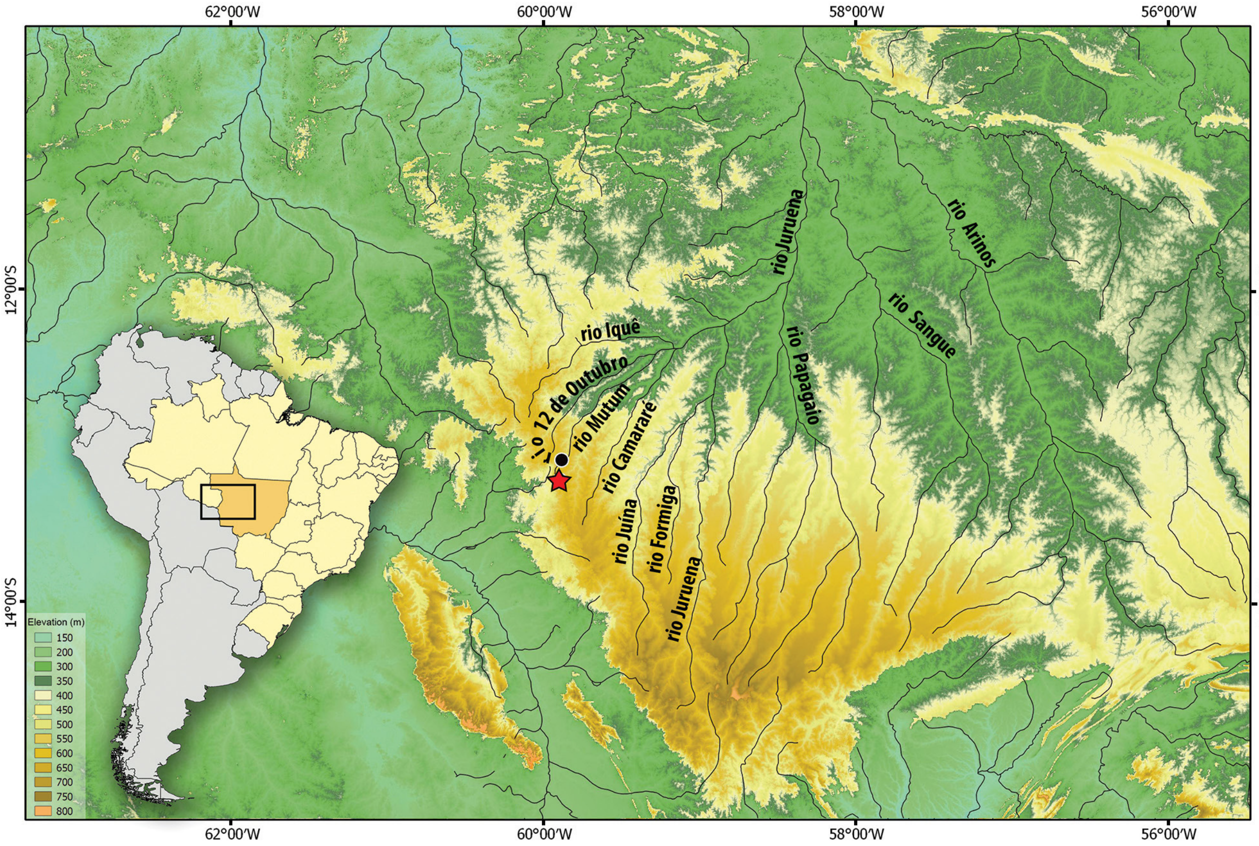

FIGURE 3 | Distribution of *Hyphessobrycon comodoro* in the upper rio Mutum, rio Juruena basin, Brazil. Red star (type locality), black dot (occurrence of other paratypes). Symbol can represent more than one collection event.

Ecological notes. Two collection sites of *Hyphessobrycon comodoro* are impoundments of tributaries of the rio Mutum formed by the road building (Fig. 4). In these habitats, the water is transparent, with maximum widths ranging 50–60 m and depth 0.3–2 m. The substrate is formed by sand, silt, and organic matter, with the presence of submerged aquatic macrophytes and large amounts of filamentous algae. The only other species collected syntopically was *Hoplerythrinus unitaeniatus* (Spix & Agassiz, 1829), probably a predator of the new species. The streams that form the lagoons are small, 2–4 m wide and 0.5–2 m deep, with clear rapid waters and a bottom composed of sand and leaf litter. Local vegetation is composed of secondary forest. The other known locality lies at the rio Mutum itself, downstream to the other two. At that point, the new species occurs syntopically with *Hyphessobrycon hexastichos* Bertaco & Carvalho, 2005 and *Hasemania nambiquara* Bertaco & Malabarba, 2007. The diet was mainly composed of resources autochthonous (91.6% of the volume of food items), mainly vegetable fragments (57.7%) and aquatic insects (32.7%). The vegetable fragments were composed of aquatic macrophyte structures and aquatic insects (fragments of adults, larvae, and pupae of Diptera and larvae of Trichoptera, and Odonata).

Specimens analyzed were sampled in a region under moderate anthropogenic pressure, which may influence the diet of fish species. Further, damming streams to road buildingchanges the taxonomic and functional of fish assemblages and limits the longitudinal dispersion (Brejão *et al*., 2020). The transformation from lotic to lentic environments, with an increase in the width of the canopy-opening channel, creates pelagic and benthic areas that allow the proliferation of macrophytes and algae (Brejão *et al*., 2020). Biological data taken from regions impacted by human action has high scientific value, but in the case of this species, it is crucial that data also be available from less impacted environments.

Etymology. The name *comodoro* is in reference to the Municipality of Comodoro, Mato Grosso State, where all the specimens were collected. It is also the name of a senior naval rank used in many navies, which inspired the municipality's name. A noun in apposition.

Conservation status. *Hyphessobrycon comodoro* is endemic to Brazil and is a restricted-range species, a common pattern among endemic characids of the 'Chapada dos Parecis' biogeographic region (Dagosta *et al*., 2020). Despite such biogeographic region was considered by those authors as one of the Endemic Amazonian Fish Areas (EAFAs), *i.e*., regions that should be considered as conservation priorities in the basin by presenting imminent threats and a low cover of protected areas, the new species is endemic to one of the most preserved river basins draining the Cerrado biome – the rio Mutum drainage. *Hyphessobrycon comodoro* is so far known by three localities, but its EOO (Extent of occurrence) is likely underestimated since only the headwater of the rio Mutum basin was sampled. Most of the rio Mutum basin lies within the

FIGURE 4 | Lagoon at the rio Mutum headwater due to the construction of a road, tributary of rio Camararé, upper rio Juruena basin, rio Tapajós basin, Comodoro, Mato Grosso, Brazil.

Nambikwara indigenous territory, where *H. comodoro* is likely to occur. Despite it has been exported in the aquarium trade it remains abundant in collection sites, which, as far as we know, are the same as those fished by the professional fishermen. Therefore, this species is assessed as Least Concern (LC) according to the International Union for Conservation of Nature (IUCN) categories and criteria (IUCN Standards and Petitions Subcommittee, 2019).

DISCUSSION

The adipose fin is variably developed in *Hyphessobrycon comodoro*, with few specimens lacking it (4 out of 27). Among Characiformes, absence of adipose fin is relatively uncommon and occurs in species of different lineages of the order (Mirande, 2019; Mattox *et al*., 2020). Among more than 6,000 living Teleostei species bearing adipose fin (Stewart *et al*., 2014, 2019), Characiformes is the only order in which its developmental pattern differs. In the Characiformes, the adipose fin develops *de novo*, *i.e*., the fin appears after the reduction of the median larval finfold, whereas in the other orders, it develops by the retention of the larval finfold between the dorsal and caudal fin (Fuiman, 1983; Bender, Moritz, 2013; Marinho, 2017; Stewart *et al*., 2014, 2019).

Absence of adipose fin in Characiformes is more frequent among miniature to small-sized species and has long been related to miniaturization (Weitzman, Malabarba, 1999; Bührnheim *et al*., 2008), although large species may also lack it (*e.g*., Erythrinidae, Mattox *et al*., 2020). Its absence in miniature to small species is probable a consequence of truncation in their development during the evolution of small-body size, in which late-forming structures, such as the "*de novo*" formation of the adipose fin, are the first to be lost (Marinho, 2017). Besides, morphological variability of characters formed in late developmental stages is also associated with body-size reduction, resulting in intrapopulational variation of that structure (Hanken, Wake, 1993; Marinho *et al*., 2021). Intraspecific variation regarding presence/absence of adipose fin has been documented for miniature to small characids (Tab. 2) and are herein interpreted as a consequence of developmental truncation. Polymorphisms are not equivalent though. The frequency of the presence of adipose fin varies among species (Fig. 5), evidencing this is a very labile character for some taxa.

Polymorphism regarding presence of adipose fin directly affect decisions on the systematic of characiforms, especially the family Characidae. This is because its absence or presence is still widely used to diagnose genera and/or species in the family. For example, *Hasemania* Ellis, 1911, was originally defined as "like a *Hyphessobrycon*, but without an adipose" (Ellis, 1911), despite species of both genera present intraespecific variation in this character (Tab. 2; Fig. 5), evidencing the fragility of such definition. Therefore, the use of such labile character in systematics needs to be made with caution. Polymorphism in the presence of adipose fin in *Hyphessobrycon comodoro*, along with the still poorly known interspecific relationships of large polyphyletic genera within Stethaprioninae (see Mirande, 2019) raise questions on the allocation of the new species in *Hyphessobrycon*. The monophyletic nature of the genus has long been disputed (Weitzman, Fink, 1983; Weitzman, Palmer, 1997; Mirande, 2010, 2019) and today, *Hyphessobrycon* is largely accepted as polyphyletic. However, some groups are likely monophyletic, such as the

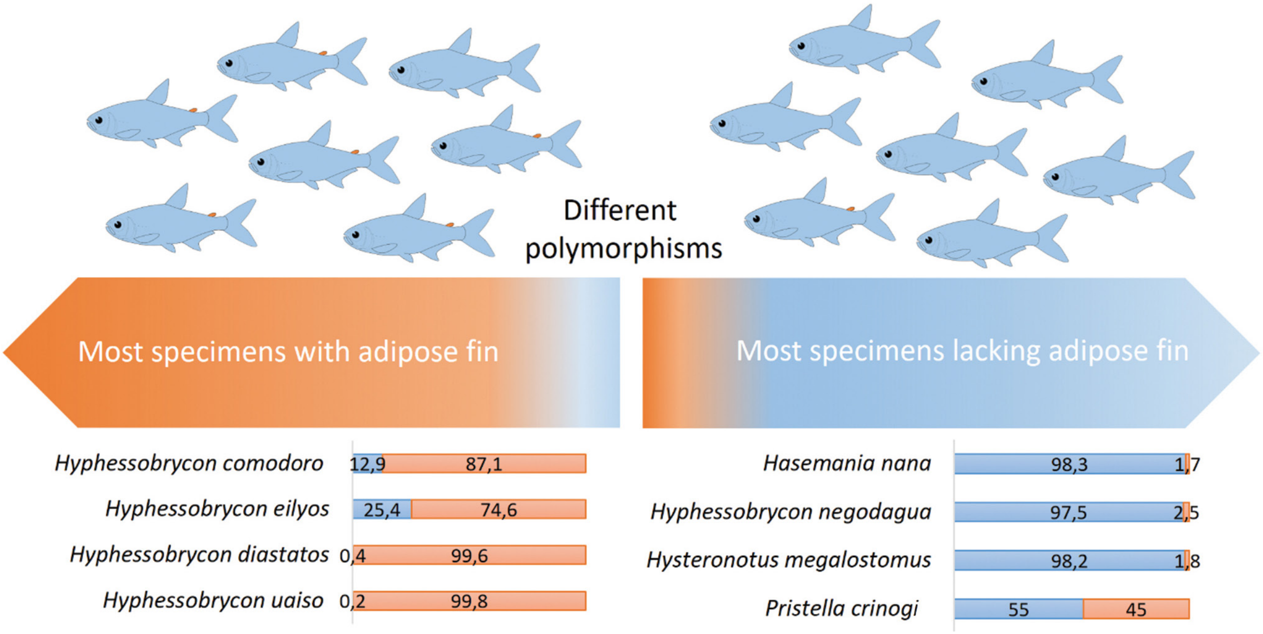

FIGURE 5 | Graph showing the adipose fin variation in characids. Note that not all polymorphisms are the same condition: some species have more specimens with developed adipose whereas other species have more specimens lacking that fin. Numbers in graphic are percentages of specimens bearing adipose fin (orange) or lacking adipose fin (blue). Further details in Tab. 2.

rosy-tetra clade (see Mirande, 2019). The evidence of monophyly of the rosy tetras has long been proposed, based in the unique coloration pattern shared by its species (Weitzman, Palmer, 1997), and was confirmed in recent cladistic works (*e.g.*, Mirande, 2019). Unfortunately, only a restricted sample of *Hyphessobrycon* could be included, not representing the whole diversity of the genus. Therefore, still needing efforts to advance the knowledge of the phylogenetic relationships of the species now attributed to *Hyphessobrycon*. As consequence, the composition, and limits of *Hyphessobrycon* remain open to question. Despite generic allocation to be tentative, the new species can be distinguished from all remaining characids by the combination of a well-defined and relatively narrow dark midlateral stripe on body extending from the upper half of the posterior margin of the eye to the middle caudal-fin ray, orange fins, a total of 33–35 scales on the longitudinal series, in which only few of them are perforated.

It is premature to infer a close evolutionary relationship between the new species with other characids, but morphological features may indicate it is more closely related to species nowadays allocated in *Hyphessobrycon*. The new species share with *H. cachimbensis*, *H. cyanotaenia*, *H. melanostichos*, *H. nigricinctus*, and *H. petricolus* a similar coloration pattern, consisting of a conspicuous, relatively narrow dark midlateral stripe from head to middle caudal-fin ray and a humeral blotch. Except for *H. nigricinctus* which is restricted to the rio Madre de Dios, *H. cachimbensis*, *H. comodoro*, *H. cyanotaenia*, *H. melanostichos*, *H. nigricinctus*, and *H. petricolus* are all endemic from the Brazilian Shield, occurring in tributaries of the rio Madeira and rio Tapajós basins. Among these species, *H. comodoro* is particularly similar to *H. melanostichos*, sharing other coloration details such as the bright orange caudal fin in life, the dark midlateral stripe starting in the upper

TABLE 2 | List of species of Characidae showing intraspecific variation in the absence/presence of the adipose fin. Counts with an asterisk include specimens with vestigial adipose fin.

Species	Specimens with adipose fin	(%)	Specimens lacking adipose fin	(%)	References
Hyphessobrycon comodoro	194*	91.9	17	8.1	Present study, MZUSP 125215
Hyphessobrycon diastatos	294	99.7	1	0.3	Dagosta *et al.* (2014)
Hyphessobrycon eilyos	153	74.6	52	25	Lima, Moreira (2003)
Hyphessobrycon uaiso	512	99.8	1	0.2	Carvalho, Langeani (2013)
Hyphessobrycon negodagua	4	2.5	158	98	Lima, Gerhard (2001)
Hysteronotus megalostomus	2	1.8	112	98	Menezes *et al.* (2016)
Pristella crinogi	15*	45.5	18	55	Lima *et al.* (2021)
Hasemania nana	3	1.7	173	98	Géry (1977), Dagosta *et al.* (2014), MZUSP 38040
Xenurobrycon macropus	?	–	?	–	Géry (1977)

half of the posterior margin of the eye, with a green to bluish stripe above it and base of anal fin sexually dimorphic, convex in males. Besides very similar morphologically, *H. comodoro* and *H. melanostichos* occur very close to each other in neighboring tributaries of the rio Camararé, Juruena river basin. They also share the fact of having a very restricted known distribution, with *H. melanostichos* so far known only from the rio Doze de Outubro and *H. comodoro* from the rio Mutum. Populations of *H. melanostichos* from shield tributaries of the rio Madeira basin (*e.g.*, rio Cabixi, rio Machado) are probably closely related undescribed species that are being studied (FCPD, pers. obs.).

The description of an additional new species already known worldwide in the aquarium trade reveals how scarce is the knowledge on the diversity of Neotropical freshwater fishes (Reis *et al.*, 2016; Albert *et al.*, 2020). Despite being widely sampled in the last decade, the Chapada dos Parecis still provides new and endemic taxa that reinforces the status of being a biogeographic region distinct from the rest of the Amazon basin (Dagosta, de Pinna, 2019; Dagosta *et al.*, 2020).

Comparative material examined. Material examined is the same listed in Dagosta *et al.* (2016), with the addition of *Hasemania nana*: Brazil, Minas Gerais, Lagoa Santa, rio São Francisco basin, MZUSP 38040, 173, 15.6–23.6 mm SL.

ACKNOWLEDGMENTS

We are grateful to Humberto Lenza for his help during fieldwork and to Michel Gianetti (MZUSP) for curatorial assistance. The authors were indebted to Karolina Reis for her support in examining ichthyological material in MZUSP. We thank Fabiano Antunes, Márcia R. Russo, and Adnara R. Gomide for administrative support at Universidade Federal da Grande Dourados (UFGD). Type series was collected at field expeditions partially funded by Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP #2017/09321–5) and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq # 405643/2018–7). Authors were supported by CNPq # 405643/2018–7, FCPD and MMFM by FAPESP # 2016/19075–9, and MMFM by FAPESP # 2018/11415–0.

REFERENCES

- **Albert JS, Tagliacollo VA, Dagosta FCP.** Diversification of Neotropical Freshwater Fishes. Annu Rev Ecol Evol S. 2020; 51:27–53. https://doi.org/10.1146/annurev-ecolsys-011620-031032
- **Bender A, Moritz T.** Developmental residue and developmental novelty – different modes of adipose-fin formation during ontogeny. Zoosyst Evol. 2013; 89(2):209–14. https://doi.org/10.1002/zoos.201300007
- **Bührnheim CM, Carvalho TP, Malabarba LR, Weitzman SH.** A new genus and species of characid fish from the Amazon basin – the recognition of a relictual lineage of characid fishes (Ostariophysi: Cheirodontinae: Cheirodontini). Neotrop Ichthyol. 2008; 6(4):663–78. https://doi.org/10.1590/S1679-62252008000400016
- **Brejão GL, Teresa FB, Gerhard P.** When roads cross streams: fish assemblage responses to fluvial fragmentation in lowland Amazonian streams. Neotrop Ichthyol. 2020; 18(3):1–16. https://doi.org/10.1590/1982-0224-2020-0031
- **Carvalho FR, Langeani F.** *Hyphessobrycon uaiso*: new characid fish from the rio Grande, upper rio Paraná basin, Minas Gerais State (Ostariophysi: Characidae), with a brief comment about some types of *Hyphessobrycon*. Neotrop Ichthyol. 2013; 11(3):525–36. https://doi.org/10.1590/S1679-62252013000300006
- **Carvalho FR, Cabeceira FG, Carvalho LN.** New species of *Hyphessobrycon* from the Rio Teles Pires, Rio Tapajós basin, Brazil (Ostariophysi, Characiformes). J Fish Biol. 2017; 91(3):750–63. https://doi.org/10.1111/jfb.13362
- **Dagosta FCP, Marinho MMF, Camelier P.** A new species of *Hyphessobrycon* Durbin (Characiformes: Characidae) from the middle rio São Francisco and upper and middle rio Tocantins basins, Brazil, with comments on its biogeographic history. Neotrop Ichthyol. 2014; 12(2):365–75. http://dx.doi.org/10.1590/1982-0224-20130179
- **Dagosta FCP, Marinho MMF, Camelier P, Lima FCT.** A new species of *Hyphessobrycon* (Characiformes: Characidae) from the upper Rio Juruena basin, Central Brazil, with a redescription of *H. cyanotaenia*. Copeia. 2016; 104(1):250–59. https://doi.org/10.1643/CI-15-243
- **Dagosta FCP, de Pinna M.** The fishes of the amazon: distribution and biogeographical patterns, with a comprehensive list of species. Bull Am Mus Nat Hist. 2019; 431:1–163. https://doi.org/10.1206/0003-0090.431.1.1
- **Dagosta FCP, De Pinna M, Peres CA, Tagliacollo VAT.** Existing protected areas provide a poor safety-net for threatened Amazonian fish species. Aquat Conserv. 2020; 31(5):1167–89. https://doi.org/10.1002/aqc.3461
- **Ellis MD.** On the species of *Hasemania*, *Hyphessobrycon*, and *Hemigrammus* collected by J. D. Haseman for the Carnegie Museum. Ann Carnegie Mus. 1911; 8(1):148–63.
- **Faria TC, Bastos DA, Zuanon J, Lima FCT.** A new *Hyphessobrycon* (Characiformes: Characidae) of the *Hyphessobrycon heterorhabdus* species-group from the Central Amazon basin, Brazil. Zootaxa. 2020; 4859(2):275–84. https://doi.org/10.11646/zootaxa.4859.2.6
- **Faria TC, Guimarães KLA, Rodrigues LRR, Oliveira C, Lima FCT.** A new *Hyphessobrycon* (Characiformes; Characidae) of the *Hyphessobrycon heterorhabdus* species-group from the lower Amazon basin, Brazil. Neotrop Ichthyol. 2021; 19(1):1–18. https://doi.org/10.1590/1982-0224-2020-0102
- **Fink WL, Weitzman SH.** The so-called Cheirodontin fishes of Central America with descriptions of two new species (Pisces: Characidae). Smithson Contrib Zool. 1974; 172:1–46.
- **Fricke R, Eschmeyer WN, Van der Laan R.** Eschmeyer's catalog of fishes: genera, species, references [Internet]. San Francisco: California Academy of Science; 2022. Available from: http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp
- **Fuiman RA.** Ostariophysi: development and relationships. In: Moser HG, Richards WJ, Cohen DM, Fahay MP, Kendall AW, Jr., Richarddson SL, editors. Ontogeny and Systematics of Fishes. California: American Society of Herpetology and Ichthyology; 1983. p. 126–37.
- **Géry J.** Characoids of the World. New Jersey: T. F. H. Publications; 1977.

- **Hanken J, Wake DB.** Miniaturization of Body Size: Organismal Consequences and Evolutionary Significance. Annu Rev Ecol Syst. 1993; 24:501–19. https://doi.org/10.1146/annurev.ecolsys.24.1.501
- **Ingenito LFS, Lima FCT, Buckup PA.** A new species of *Hyphessobrycon* Durbin (Characiformes: Characidae) form the rio Juruena basin, central Brazil, with notes on *H. loweae* Costa & Géry. Neotrop Ichthyol. 2013; 11(1):33–44. https://doi.org/10.1590/S1679-62252013000100004
- **International Union for Conservation of Nature (IUCN).** Standards and petitions committee. Guidelines for using the IUCN Red List categories and criteria. Version 14 [Internet]. Prepared by the Standards and Petitions Committee; 2019. Available from: https://www.iucnredlist.org/resources/redlistguidelines
- **Lima FCT, Gerhard P.** A new *Hyphessobrycon* (Characiformes: Characidae) from Chapada Diamantina, Bahia, Brazil, with notes on its natural history. Ichthyol Explor Fres. 2001; 12(2):105–14.
- **Lima FCT, Moreira CR.** Three new species of *Hyphessobrycon* (Characiformes: Characidae) from the upper rio Araguaia basin in Brazil. Neotrop Ichthyol. 2003; 1(1):21–33. https://doi.org/10.1590/S1679-62252003000100003
- **Lima FCT, Caires RA, Conde-Saldaña CC, Mirande JM, Carvalho FR.** A new miniature *Pristella* (Actinopterygii: Characiformes: Characidae) with reversed sexual dimorphism from the rio Tocantins and rio São Francisco basins, Brazil. Can J Zool. 2021; 99:339–48. https://doi.org/10.1139/cjz-2020-0241
- **Marinho MMF, Dagosta FCP, Camelier P, Oyakawa OT.** A name for the ‘blueberry tetra’, an aquarium trade popular species of *Hyphessobrycon* Durbin (Characiformes: Characidae), with comments on fish species descriptions lacking accurate type locality. J Fish Biol. 2016; 89(1):510–21. https://doi.org/10.1111/jfb.12991
- **Marinho MMF, Ohara W, Dagosta FCP.** A new species of *Moenkhausia* (Characiformes: Characidae) from the rio Madeira basin, Brazil, with comments on the evolution and development of the trunk lateral line system in characids. Neotrop Ichthyol. 2021; 19(2): e200118. https://doi.org/10.1590/1982-0224-2020-0118
- **Marinho MMF.** Comparative development in *Moenkhausia pittieri* and *Paracheirodon innesi* (Ostariophysi: Characiformes) with comments on heterochrony and miniaturization in the Characidae. J Fish Biol. 2017; 91(3):851–65. https://doi.org/10.1111/jfb.13384
- **Mattox GMT, Souza CS, Toledo-Piza M, Britz R, Oliveira C.** A new miniature species of *Priocharax* (Teleostei: Characiformes: Characidae) from the Rio Madeira drainage, Brazil, with comments on the adipose fin in characiformes. Vertebr Zool. 2020; 70(3):417–33. https://doi.org/10.26049/VZ70-3-2020-11
- **Menezes NA, Weitzman SH, Teixeira TF.** Redescription of *Hysteronotus megalostomus* (Characiformes: Characidae: Stevardiinae), a poorly known characid from tributaries of the Rio São Fancisco, Brazil with comments on the conservation of the species. J Fish Biol. 2016; 89(1):495–509. https://doi.org/10.1111/jfb.13000
- **Mirande JM.** Phylogeny of the family Characidae (Teleostei: Characiformes) from characters to taxonomy. Neotrop Ichthyol. 2010; 8(3):385–568. https://doi.org/10.1590/S1679-62252010000300001
- **Mirande JM.** Morphology, molecules and the phylogeny of Characidae (Teleostei, Characiformes). Cladistics. 2019; 35(3):282–300. https://doi.org/10.1111/cla.12345
- **Pastana MNL, Dagosta FCP, Esguícero ALH.** A new sexually dichromatic miniature *Hyphessobrycon* (Teleostei: Characiformes: Characidae) from the Rio Formiga, upper Rio Juruena basin, Mato Grosso, Brazil, with a review of sexual dichromatism in Characiformes. J Fish Biol. 2017; 91(5):1301–18. https://doi.org/10.1111/jfb.13449
- **Reis RE, Albert JS, Di Dario F, Mincarone MM, Petry P, Rocha LA.** Fish biodiversity and conservation in South America. J Fish Biol. 2016, 89(1):12–47. https://doi.org/10.1111/jfb.13016
- **Sabaj MH.** Codes for Natural History Collections in Ichthyology and Herpetology. Copeia. 2020; 108(3):593–669. https://doi.org/10.1643/ASIHCODONS2020
- **Stewart TA, Smith WL, Coates MI.** The origins of adipose fins: an analysis of homoplasy and the serial homology of vertebrate appendages. P R Soc B. 2014; 281(1781):20133120. https://doi.org/10.1098/rspb.2013.3120

- **Stewart TA, Bonilla MM, Ho RK, Hale ME.** Adipose fin development and its relation to the evolutionary origins of median fins. Sci Rep. 2019; 9(1):1–12. https://doi.org/10.1038/s41598-018-37040-5
- **Taylor WR, Van Dyke GC.** Revised procedures for staining and clearing small fishes and other vertebrates for bone and cartilage study. Cybium. 1985; 9(2):107–19.
- **Weitzman SH, Palmer L.** A new species of *Hyphessobrycon* (Teleostei: Characidae) from the Neblina region of Venezuela and Brazil, with comments on the putative ‘rosy tetra clade’. Ichthyol Explor Fres. 1997; 7(3):209–42.
- **Weitzman SH, Malabarba LR.** Systematics of *Spintherobolus* (Teleostei: Characidae: Cheirodontinae) from Eastern Brazil. Ichthyol Explor Fres. 1999; 10(1):1–43.
- **Weitzman SH, Fink WL.** Relationships of the neon tetras, a group of South American freshwater fishes (Teleostei, Characidae), with comments on the phylogeny of New World Characiforms. Bull Mus Comp Zool. 1983; 150(6):339–95.

AUTHORS’ CONTRIBUTION

Fernando Cesar Paiva Dagosta: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing-original draft, Writing-review and editing.

Thomaz Jefrey Seren: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Writing-original draft, Writing-review and editing.

Anderson Ferreira: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Writing-original draft, Writing-review and editing.

Manoela Maria Ferreira Marinho: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Writing-original draft, Writing-review and editing.

ETHICAL STATEMENT

Type series was collected under Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA License number 60634, 2017–2020).

COMPETING INTERESTS

The authors declare no competing interests.

HOW TO CITE THIS ARTICLE

- **Dagosta FCP, Seren TJ, Ferreira A, Marinho MMF**. The emerald green tetra: a new restricted-range *Hyphessobrycon* (Characiformes: Characidae) from the upper rio Juruena, Chapada dos Parecis, Brazil. Neotrop Ichthyol. 2022; 20(1):e210119. https://doi.org/10.1590/1982-0224-2021-0119

Neotropical Ichthyology

SBI
Official Journal of the
Sociedade Brasileira de Ictiologia