



## *Hyphessobrycon oritoensis* (Characiformes: Characidae), a new species from the Putumayo River drainage, Colombian Amazon

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### Abstract

*Hyphessobrycon oritoensis* (Characiformes: Characidae) is described from the Putumayo River drainage of the Colombian Amazon. The new species belongs to the *H. heterorhabdus* group and is distinguished from all other known species by the following combination of characters: iii,8 dorsal-fin rays, iv, 26–27 anal-fin rays, 19 teeth on dentary, 35 scales in longitudinal series, 10–11 perforated scales in lateral line, 7 scales between lateral line and dorsal-fin origin, 14 predorsal scales and a dark lateral band that extends from the posterior border of the humeral spot to the tips of the middle caudal fin rays.

**Key words:** Characid fish, Colombia, South America

### Resumen

Se describe *Hyphessobrycon oritoensis* (Characiformes: Characidae) de la cuenca del río Putumayo en la Amazonia colombiana. La nueva especie pertenece al grupo *H. heterorhabdus* y se distingue de las otras especies descritas por la siguiente combinación de caracteres: radios dorsales: iii,8, radios anales: iv, 26–27, 19 dientes en el dentario, 35 escamas en la serie lateral del cuerpo, 10 a 12 escamas con poros en la línea lateral, 7 escamas entre la línea lateral y la aleta dorsal, 14 escamas predorsales y una franja lateral oscura que extiende desde el borde posterior de la mancha humeral hasta los extremos de los radios caudales centrales.

### Introduction

The genus *Hyphessobrycon* Durbin in Eigenmann, 1908, contains 110 valid species (Lima *et al.* 2003; Lima & Moreira 2003; Lucena 2003; Almirón *et al.* 2004; Bertaco & Malabarba 2005) distributed from southern Mexico to Argentina. It is artificially defined by the following combination of characters: maxillary teeth few or absent, lateral line incomplete, third orbital bone not in contact with the sensory canal of the preopercle, two series of teeth on the premaxillary, and caudal fin without scales at base, this last character is the only difference separating it from *Hemigrammus* Gill. However, as many authors have pointed out, these characters do not suffice to diagnose the genus, and *Hyphessobrycon* as defined is not monophyletic (Weitzman & Palmer 1997; Moreira *et al.* 2002; Malabarba & Weitzman 2003; Bertaco & Malabarba 2005; Calcagnotto *et al.* 2005).

Eigenmann (1922, 1927) revised *Hyphessobrycon* and proposed that it is a subgenus of *Hemigrammus*, but provided no phylogenetic perspective to support this claim. Géry (1977) created artificial groups of spe-

cies based on pigmentation patterns; of particular interest here is the *H. heterorhabdus*-group, defined as those species with a dark lateral stripe. Eschmeyer (2005) listed 21 species in the *H. heterorhabdus*-group, which reaches its greatest diversity in the cis-Andean region, specifically in the Amazon River basin. Four species are reported for Colombia: *H. heterorhabdus* Ulrey 1894, *H. poecilioides* Eigenmann 1913, *H. proteus* Eigenmann, 1913 and *H. diancistrus* Weitzman 1977.

In this paper we describe a new species of *Hyphessobrycon* of the *heterorhabdus* group, providing morphometric, pigmentation and osteological characters to distinguish it from its congeners.

## Material and methods

Material was preserved in 10% formalin, transferred to 70% ethyl alcohol and deposited in the Ichthyological Laboratory of the Universidad del Quindío, Armenia, Colombia (IUQ); in the Museo de Biología, Universidad Central de Venezuela, Caracas (MBUCV), and in the Museo de Ciencias Naturales de Guanare, Universidad Experimental de los Llanos Occidentales “Ezequiel Zamora”, Guanare, Venezuela (MCNG). Additional comparative material was examined from the following museums: the Academy of Natural Sciences of Philadelphia (ANSP), the Instituto de Ciencias Naturales–Museo de Historia Natural, Universidad Nacional de Colombia, Bogotá (ICN–MNH), the Museo de Historia Natural La Salle, Caracas, Venezuela (MHNLS) and the Colección de Peces de la Universidad Centro Occidental “Lisandro Alvarado”, Barquisimeto, Venezuela (CPUCLA). The number of specimens per lot is given in parentheses. Measurements were taken with digital calipers to the nearest hundredth of a millimeter. All measurements were taken as point to point. Counts of fin rays, scales and teeth were done with a stereoscope and dissecting needle, and were taken from the left side of the specimens when possible (Table 1). Counts and measurements follow Weitzman & Malabarba (1999). Observations on bone and cartilage are from cleared and stained specimens (C&S) using techniques outlined by Taylor & Van Dyke (1985), and Song & Parenti (1995). Osteological nomenclature follows Weitzman (1962), Vari (1995) and Ruiz-Calderón & Román-Valencia (2006). The 21 characters examined in this study (Table 1) were analyzed using principal component analysis (PCA), using the computer software, paleontological statistics (PAST) version 1,80.

### *Hyphessobrycon oritoensis*, new species

Table 1, Figs. 1–3

**Holotype:** IUQ 1574, 24.63 mm SL; Colombia, Putumayo, Orito, Quebrada La Palma, finca La Palma, Vereda Calimonte, 29 Jun. 1998. Approximately 0° 41' N & 75° 52' W. C. Román-Valencia, J. Tovar & H. Hoyos.

**Paratypes:** IUQ 139, (6 ex.) collected with the holotype. IUQ 1575, (2 ex.) (C. & S.) collected with the holotype; MBUCV–V 33737, (2 ex.) collected with the holotype; MCNG 55844, (2 ex.) collected with the holotype; Colombia, Putumayo, Orito, Quebrada La Palma, finca La Palma, Vereda Calimonte, 29 Jun. 1998. Approx. 0° 41' N & 75° 52' W. C. Román-Valencia, J. Tovar & H. Hoyos. 26.19–42.77 mm SL.

**Diagnosis:** *Hyphessobrycon oritoensis* is distinguished from all congeners by having three simple and eight branched rays in the dorsal fin (vs. two simple and nine branched rays, except *H. notidanos* which has iii, 8); four simple and 26–27 branched anal-fin rays (vs. three simple and 17–24 branched rays); 19 teeth on the dentary (vs. 6–12); 35 lateral line scales (vs. 31–34, except for *H. heterorhabdus* which has 37); 10–11 pored lateral-line scales (vs. 8–9); seven longitudinal scale rows from the lateral line to the dorsal fin (vs. five, except in *H. heterorhabdus* with seven) and fourteen predorsal scales (vs. 10–11). *Hyphessobrycon oritoensis* is distinguished in detail from *H. notidanos* in the “Remarks” section below.

**TABLE 1.** Morphometric and meristic data for *Hyphessobrycon oritoensis* n. sp. Standard and total length in mm. Means given in parentheses. Standard deviation = SD.

Morphometric:	Holotype	Paratype n= 13	SD
Standard length (mm)	34.63	26.19–42.77 (34.50)	4,29
Total length	45.51	33.01–54.15 (43.35)	5,36
Percentages of SL:			
1. Body depth	43.66	37.84–45.59 (42.00)	2,45
2. Snout–dorsal fin distance	58.53	49.82–58.53 (52.81)	2,00
3. Snout–pectoral fin distance	28.32	24.85–28.32 (26.48)	1,22
4. Snout–pelvic fin distance	48.33	40.05–51.40 (46.14)	2,95
5. Snout–anal fin distance	61.44	56.71–65.05 (59.61)	2,72
6. Dorsal fin–hypural length	49.37	46.22–56.47 (52.01)	2,36
7. Dorsal fin–anal fin length	41.32	35.85–43.67 (40.34)	2,02
8. Dorsal fin–pectoral fin length	47.41	26.54–49.94 (44.95)	5,72
9. Dorsal fin length	29.8	25.35–31.04 (28.60)	1,53
10. Pectoral fin length	24.14	19.26–24.14 (21.20)	1,26
11. Pelvic fin length	13.74	12.48–19.78 (16.09)	2,15
12. Anal fin length	23.21	11.17–24.41 (19.34)	4,12
13. Caudal peduncle depth	11.89	10.01–12.81 (11.78)	0,69
14. Caudal peduncle length	6.81	5.94–11.10 (8.79)	1,57
15. Head length	28.38	26.69–31.37 (28.91)	1,19
Percentages of HL:			
16. Snout length	33.67	20.39–33.67 (24.76)	3,28
17. Orbital diameter	37.02	31.01–42.48 (37.05)	2,57
18. Postorbital distance	57.57	42.71–57.57 (50.51)	4,47
19. Maxilla length	33.26	25.69–37.41 (30.22)	3,61
20. Interorbital distance	38.86	35.57–44.23 (38.54)	2,12
21. Upper jaws length	29.39	27.25–36.69 (31.45)	2,68
Meristic:			
Lateral line scales	10	9–11	0,36
lateral scales	35	35	0
Scale rows between dorsal–fin origin and lateral line	7	7	0
Scale rows between anal–fin origin and lateral line	5	5	0
Scale rows between pectoral–fin origin and lateral line	5	5	0
Scale rows between pelvic–fin origin and lateral line	6	6–7	0,47
Predorsal median scales	12	12–14	0,63
Dorsal–fin rays	iii, 8	iii, 8	
Anal–fin rays	iv, 26	iv, 26–27	
Pelvic–fin rays	ii, 6	ii, 6–7	
Pectoral–fin rays	ii, 10	ii, 10–11	

**Description:** Morfometric and meristic data are given in Table 1. Body short and deep, dorsal profile of head and body oblique from snout to supraoccipital, convex from there to dorsal fin origin, and from the last

dorsal-fin ray to the base of the caudal fin. Ventral profile of body convex from snout to base of anal fin, more pronounced behind pectorals. Head and snout short; mandibles equal; mouth subterminal; lips soft and flexible, not covering the external row of premaxillary teeth; ventral part of the upper jaw flat; posterior end of maxilla passing anterior border of orbit.



**FIGURE 1.** *Hyphessobrycon oritoensis*. Holotype; 34.63 mm SL; Colombia, Putumayo, Rio Orito, Amazon basin.

Premaxillary with a long lateral process, pointed and with two rows of teeth (Fig. 2); the external row with 3–4 tricuspid teeth arranged in zig zag; the internal row with 5–6 tricuspid teeth, diminishing gradually in size from inner to outer laterally. Maxilla long with 5–6 tricuspid teeth, and with posterior end reaching the posterior edge of second infraorbital; maxilla with two small foramina near upper margin of the tooth series. Two pentacuspoid teeth in front of dentary, followed by three tricuspid lateral teeth larger than the rest, followed by 14 small conic teeth.

Six infraorbitals, the third longest in width, wide but not in contact with the sensory canal of preopercle; fourth infraorbital the smallest of series. Antorbital with anterior border concave. Supraorbital absent.

Rhinospheonid heavily ossified, united with orbitospheonid by a band of cartilage that extends above its posterior border; cartilage band extends to the dorso–anterior end and is in contact with the postero–dorsal margin of the prevomer. Orbitospheonid heavily ossified with a round apophysis on anterior part. Paraspheonid not divided, united to ventral surface of vomer; posterior end of paraspheonid in contact with prootic and basioccipital through a band of cartilage. Metapterygoid with upper margin wide and two crests, a small foramen in postero–medial region, with a band of cartilage along anterior and posterior edges. Ectopterygoid elongate and wide, in contact via cartilage with the quadrate. Nasal bone present. Basihyal cartilaginous and divided in two. Pharyngeal plate elongate and curved, having cartilage on the dorsal and antero–ventral edges. 16 gill rakers on first arch.

Total number of vertebrae 34–35. Proximal dorsal pterygiophores inserted between neural spines 10 and 17; 28 radial pterygiophores in anal fin. Four to five supraneurals present with cartilage on their dorsal and ventral ends. Pectoral girdle with a pointed dorsal elongation. Cleithrum elongate, widening near posterior edge and with the margin wavy, located below the ventral edge of the opercle. Scapula united to internal surface of cleithrum by cartilage. Postcleithrum 3 elongate and curved with a rounded laminar bony prolongation of its postero–medial edge. Four proximal radials present.

Edge of dorsal fin oblique. Pelvic fin short, tip not reaching anal-fin origin. Pelvic bone elongate and straight, parallel to medial area of body with cartilage on anterior and postero–lateral edges; ischial process short, curved, with pointed apophysis cartilaginous. Caudal fin forked, with long pointed lobes, scaleless. Principal caudal rays 9/8 (n=14).

**Sexual dimorphism.** No apparent sexual dimorphism was observed.

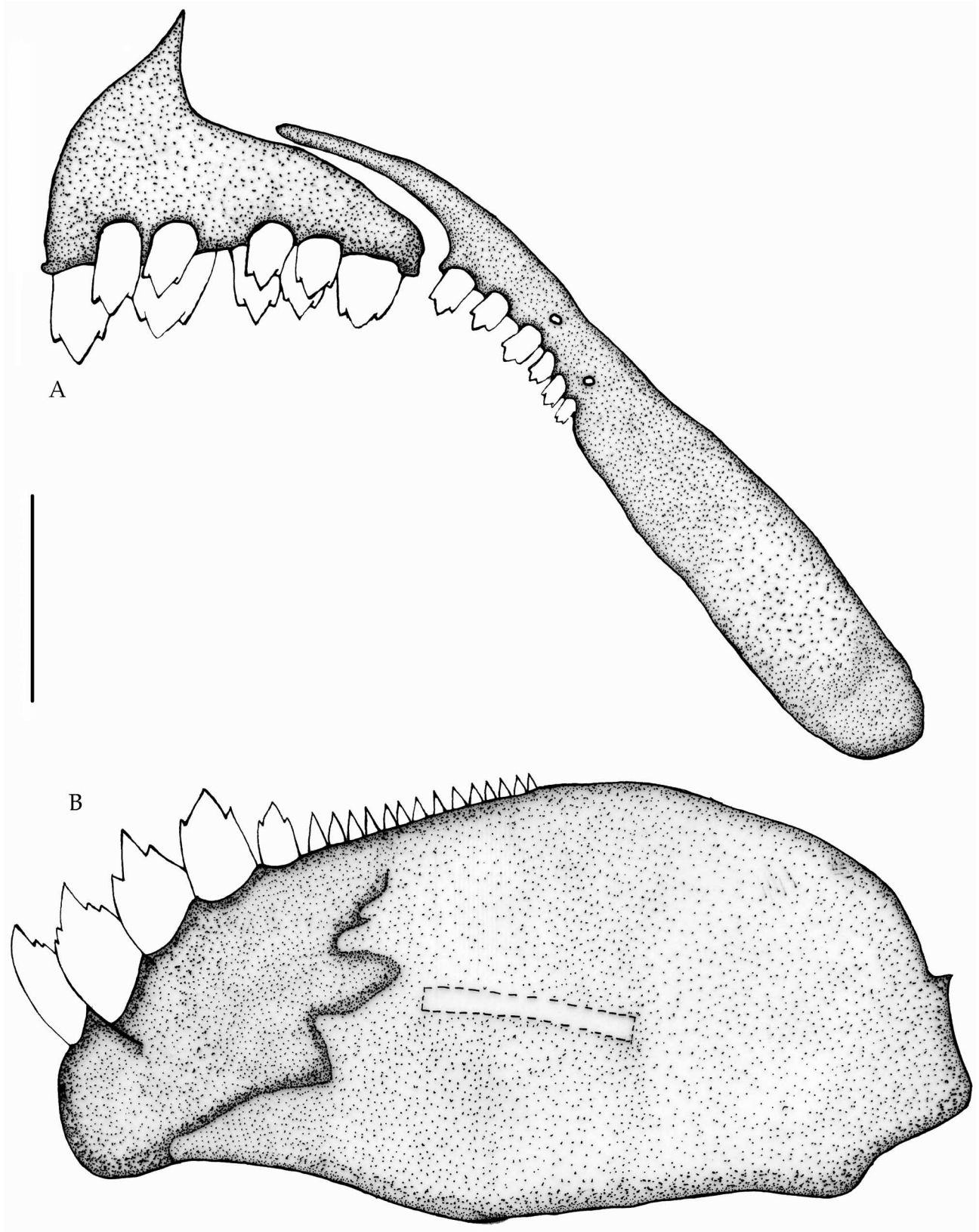


FIGURE 2. Upper (A) and lower jaws (B) of *Hyphessobrycon oritoensis*, IUQ 1575, paratype.

**Color in alcohol:** Body light yellow, lateral portion of body with dark band from behind humeral spot to tips of central caudal fin rays, wider beneath dorsal fin origin. Humeral spot dark. Guanine present dorsally and laterally in many specimens. Posterior edge of scales on dorsum and upper side black. Tip of caudal lobes

dark. Dorsal, anal, pectoral and pelvic fins hyaline. Anal fin lightly pigmented at tips of rays. Head darker than body.

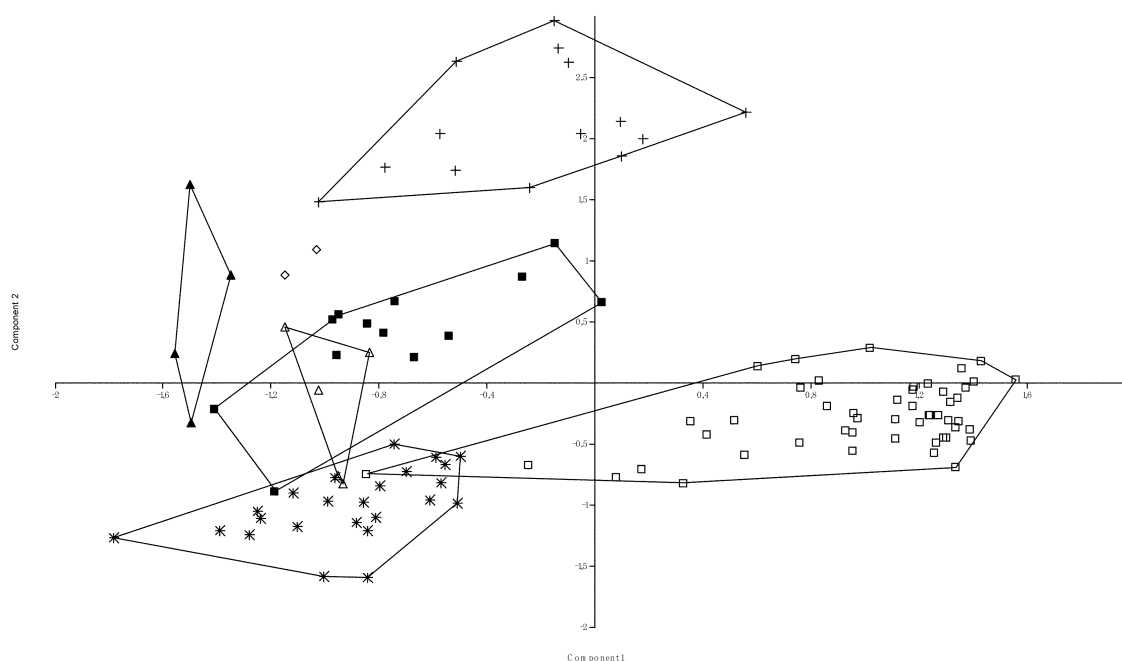
**Distribution:** Only known from the type locality.

**Etymology:** Named for the collection site, the Orito River in the Putumayo drainage, Amazonía, Colombia.

**Remarks:** The new species is very similar to *H. notidanos*, however it differs from it in the number of lateral scales (35 vs. 32–34 in *H. notidanos*), in the number of pored scales (12–14 vs. 9–11), in the number of scale rows between dorsal–fin origin and lateral line (7 vs. 6), in the number of predorsal median scales (12–14 vs. 9–11), in the number of teeth in the dentary (19 vs. 7), in the number of teeth in the maxillary (5–6 vs. 2–4) in the dorsal–fin rays (iv, 26–27 vs. iii, 17–20), in body depth (37.84–5.59% LS vs. 36.84–37.79% LS) and in the snout–anal fin distance (56.71–65.05% LS vs. 62.52–80.39% LS).

Principal components analysis (fig. 3) indicates that *Hyphessobrycon oritoensis* n. sp. is distinguished from *Hyphessobrycon poecilioides*, *H. heterorhabdus*, *H. vilmae*, *H. melanostichos*, *H. diancistrus* and *H. notidanos* in axis 1 by caudal peduncle depth in relationship to upper jaw length; and in axis 2, by body depth vs. dorsal fin–anal fin length. The first component explains 89.60% of the total variance, and combined with the second component they explain 92.74% of total variability.

**Ecological notes:** Data obtained from two stomachs of cleared and stained specimens indicates that this species is probably mostly insectivorous, feeding on allocthonous material, with unidentified insect parts being the most important element (56% by Number of prey items and 31% by Volume), followed by odonate larvae (8% N and 10% V), vegetable matter (16% N and 11% V) and unidentifiable material (20% N and 48% V). Their habitat had clear water over a substrate of sand and stone, with low dissolved oxygen (5.2 mg/l), 67% saturation and pH 6.0.



**FIGURE 3.** Principal components analyses (PCA) (component 1 in the axis X, component 2 in the axis Y) of morphometrics data in *Hyphessobrycon oritoensis* n. sp. (+), *H. poecilioides* (□), *H. heterorhabdus* (■), *H. vilmae* (△), *H. melanostichos* (▲), *H. diancistrus* (\*) and *H. notidanos* (◇)

## Discussion

Géry (1977), in his key to the species of *Hyphessobrycon*, recognized six artificial groups based on pigmentation patterns. *Hyphessobrycon oritoensis* belongs to the *heterorhabdus* group of species that have a dark lat-

eral band. The number of rays in the dorsal fin in species of *Hyphessobrycon* is usually ii, 9, but all specimens of *H. oritoensis* examined (n=14) had iii, 8, and this same pattern was also seen in *H. notidanos* (Carvalho & Betarco 2006) and some specimens of *H. weitzmanorum* (Lima & Moreira 2003), a strange count for this genus and even for species of Characidae, which could suggest a close relationship among these taxa. The rotated second tooth of the dentary exposed on the outside of the front row of teeth is not usual in other characid genera but typical of all *Hyphessobrycon* examined (pers. obs.); these characteristics could prove to be a derived for this genus.

The ventral part of the supraoccipital unites with the exoccipital arch by a band of cartilage, and while not frequent in Characidae, has been observed in *Astyanax aurocaudatus* (Géry) (Ruiz-Calderón & Román-Valencia 2006), and in *Hemibrycon pautensis* (Román-Valencia *et al.* 2006).

Weitzman & Palmer (1997) inferred the existence of a monophyletic group within *Hyphessobrycon* based on a shared, complex model of coloration of the dorsal and anal fins, and other anatomical evidence, calling this group the 'rosy-tetra clade'. Lima & Gerard (2001) noted that the coloration model could be a good starting point from which we might elucidate the complex systematics of *Hyphessobrycon* and related genera, given that the pattern might indicate a close phylogenetic relationship. So, while the *heterorhabdus* group should be evaluated from a phylogenetic perspective to try to clarify the relationships of the subgroups within *Hyphessobrycon*, a comprehensive discussion of the relationships of *Hyphessobrycon oritoensis* is not possible at this time due to our poor knowledge of the systematics of the genus.

### Comparative material examined

*Hyphessobrycon compressus*: BMNH 1905.12.6.4-5 (Paratype), (2 ex.); México, Obispo, Vera Cruz. ANSP 124774 (12 ex.); México, Río Usumacinta casi unido con Pasión, cerca Sayache, 18 Ago. 1961. IBUAMP 8538, (2 ex.); México, trinitaria, Flor de Café, Chris, 03 Jul. 1993. ANSP 124774; México, (3) (C&S), Río Usumacinta casi unido con Pasión, cerca Sayache, 18 Ago. 1961. *Hyphessobrycon poecilioides*. CAS 77396 (Paratypes) (5 ex.): Colombia, Pequeña quebrada cerca a Cali, Cuenca del río Magdalena, 03 Feb. 1912. IUQ 519, (46 ex.); Colombia, Valle, quebrada El Indio, 100 m. en el peaje vía Alambrado–Corozal, 5 Dec. 2003. IUQ 517, (33 ex.); Colombia, Valle, quebrada El Indio, 100 m. en el peaje vía Alambrado–Corozal, 12 Sep. 2004. MCNG 55351, (4 ex.); Colombia, quebrada El Indio, 100 m. en el peaje vía Alambrado–Corozal, Valle, 5 Dec. 2003. *Hyphessobrycon proteus*. CAS 60483 (Syntype) (5 ex.); Colombia, Soplaviento, 25 May. 1913. CAS 60479 (Sintypes) (3 ex.); Colombia, Quebrada Bernal, 1913. IUQ 249, (5 ex.); Colombia, Atlántico, Jagüey Parrish, cerca del arroyo hondo, a un lado de Barranquilla, 4 Mar. 1990. IUQ 1009, (25 ex.); Colombia, Bolívar, Ciénaga de Capote, en soplaviento, bajo Magdalena, 31 May. 2003. *Hyphessobrycon heterorhabdus*. ICNMMNH 5063, (10 ex.); Colombia, Amazonas, Río Puré, Leticia 02° 07' 05" S y 69° 37' 50" W, 8 Jan. 2000. MCP 41577 (5 ex.); Brazil, Para, Igarapé Acuí, 01° 35' 46" S & 48° 44' 26" W, 21 Oct. 2006. *H. diancistrus*: BMNH 1977.1.12.1-2 (Paratype), (2); Colombia, Rio Vichada. MBUCV-V 902, (3) (C & T); Venezuela, Río Cataniapo, aguas abajo del caño Colorado, río abajo de la comunidad de San Pedro, Amazonas, 26 Apr. 2002. MBUCV-V 14065, (2); Venezuela, Caño Las Pavas, afluente del río Cataniapo, Amazonas, 05°34'00" N y 67°30'36" W, 25 Jul. 1982. MBUCV-V 24479, (17); Venezuela, Río Cataniapo, raudal Rabipelado, carretera Puerto Ayacucho-Gavilán, Amazonas, 05° 33' 08" N y 67° 20' 52" W, 29 Mar. 1993. MBUCV-V 30867, (6); Venezuela, Caño Gavilán, laja en Cucurital, aproximadamente 1/2 hr. de Gavilán, Amazonas, 30 Apr. 2002. *Hyphessobrycon sovichthys*: MBUCV–V 18267, (88 ex.); Venezuela, Hacienda La Abeja río Cachiri, en compuerta de la Hacienda La Abeja, cerca del Embalse Cachiri, Tule, Zulia, 4 Dec. 1982. MCNG 42742, (30 ex.); Venezuela, Caño La Yuca, 50 km al sureste de Encontrados, Zulia, 20 Dec. 1999. ICNMMNH 2360, (5 ex.); Colombia, Rio la Gabarra cuenca del río Catatumbo, Norte de Santander, 1 Feb. 1995. *Hyphessobrycon vilmae*: MCP 38881 (5 ex.); Brasil, Rio Papagaio en frente al balneario do pubi, Mato grosso 13° 33' 35" S & 58° 24' 31" W, 13 Jul. 2004. *Hyphessobrycon coelestinus*: MCP 27216 (1 ex.); Brasil, Distrito Federal, Alto Parana Banhado afluente da lagoa Bonita, Proximo a planaltina 15° 34' 19" S & 47° 41' 08" W, 13 Jul. 1998. *Hyphessobrycon malanostichos*: MCP 39808 (5 ex.); Brasil, Rio Doze de Outubro, entre Comodoro e Vil-

hena, 12° 35' 46" S & 60° 00' 30" W, 14 Jul. 2004. *Hyphessobrycon notidanus*: MCP 38676 (Paratypes) (2 ex.); Brasil, rio Doze de Outubro, entre Comodoro e Vilhena. 12° 58' 39" & 60° 00' 30" W, 14 Jul. 2004. MCP 38676 (1 ex.)(C&S) Brasil, rio Doze de Outubro, entre Comodoro e Vilhena. 12° 58' 39" & 60° 00' 30" W, 14 Jul. 2004.

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## References

- Almirón, A., Casciotta, J., Bechara, J. & Ruiz-Díaz, F. (2004) A new species of *Hyphessobrycon* (Characiformes, Characidae) from the Esteros del Iberá wetlands, Argentina. *Revue Suisse de Zoologie*, 111 (3), 673–682.
- Bertaco, V.A. & Malabarba, L. R. (2005) A new species of *Hyphessobrycon* (Teleostei: Characidae) from the upper Rio Tocantins drainage, with bony hooks on fins. *Neotropical Ichthyology*, 3 (1), 83–88.
- Calcagnotto, D., Schaefer S.A. & DeSalle, R. (2005) Relationships among characiform fishes inferred from analysis of nuclear and mitochondrial gene sequences. *Molecular Phylogenetics and Evolution*, 36, 135–153.
- Carvalho, T.P. & Bertaco, V.A. (2006) Two new species of *Hyphessobrycon* (Teleostei: Characidae) from upper rio Tapajós basin on Chapada dos Parecis, Central Brazil. *Neotropical Ichthyology*, 4(3), 301–308.
- Eigenmann, C.H. (1908) Zoological results of the Thayer Brazilian expedition. Preliminary description of new genera and species of tetragonopterid characins. *Bulletin of Museum of Comparative Zoology*, 52(6), 93–106.
- Eigenmann, C.H. (1913) *Some results from an ichthyological reconnaissance of Colombia, South America, Part II*. Indiana University Studies, 18, 1–32.
- Eigenmann, C.H. (1922) *The Fishes of Northwestern South America, Part I. The Fresh-water Fishes of Northwestern South America, including Colombia, Panama, and the Pacific slopes of Ecuador and Perú, together with an appendix upon the fishes of the Rio Meta in Colombia*. *Memories Carnegie Museum*, 9(1), 1–346.
- Eigenmann, C.H. & Ogle, F. (1907) An annotated list of the characin fishes in the United States National Museum and the Museum Indiana University with description of new species. *Proceedings United States National Museum*, 33, 1–36.
- Eschmeyer, W. (2005) *CAS. Ichthyology—Catalog of fishes, California Academy of Sciences, San Francisco, CA, USA*. 2905 p. Available from, <http://www.calacademy.org/research/ichthyology/catalog/fishcatsearch.html> (July 22 of 2007)
- Géry, J. (1977) *Characoids of the world*. Neptune City: T.F.H. Publications, 672 p.
- Lima, F. & Gerhard, P. (2001) A new *Hyphessobrycon* (Characiformes: Characidae) from Chapada Diamantina, Bahia, Brazil, with notes on its natural history. *Ichthyological Exploration of Freshwaters*. 12(2), 105–114.
- Lima, F. & Moreira, C. (2003) Three new species of *Hyphessobrycon* (Characiformes: Characidae) from the upper rio Araguaia basin in Brazil. *Neotropical Ichthyology*, 1(1), 21–33.
- Lima, F., Malabarba, L., Buckup, P., Pezzi Da Silva, J., Vari, R., Harold, A., Benine, R., Oyakawa, O., Pavanelli, C., Menezes, N., Lucena, C., Malabarba, M., Lucena, Z., Reis, R., Langeani, F., Casatti, L., Bertaco, V., Moreira, C. & Lucinda, P. (2003) Genera Incertae Sedes in Characidae. In: Reis, R., Kullander, S. & Ferraris, C. (eds.), (2003) *Check List of the Freshwater Fishes of South and Central America*. Edipucrs, Porto Alegre, Pp. 106–169
- Lucena, C. (2003) New characid fish, *Hyphessobrycon scutulatus*, from the rio Teles Pires drainage, upper Rio Tapajós system (Ostariophysi: Characiformes: Characidae). *Neotropical Ichthyology*, 1(2), 93–96.
- Malabarba, L. & Weitzman, S. (2003) Description a new genus with new species from southern Brazil, Uruguay and Argentina, with a discussion of a putative characid clade (Teleostei: Characiformes:Characidae). *Comunicações do Museu de Ciências e Tecnologia da PUCRS, Série Zoologia, Porto Alegre*, 16(1), 67–151.



- Meek, S.E. (1904) The fresh-waters fishes of the México North of the Isthmus of Tehuantepec. *Field Columbian Museum Publication 93, Zoological Series, 5*, 87–88.
- Moreira, C., Landim, M. & Costa, W. (2002) *Hyphessobrycon heliacus*: A new characid fish (Ostariophysi: Characiformes) from the upper no Tapajós basin, central Brazil. *Copeia*, 2, 428–432.
- Román-Valencia, C., Ruiz, R. & Barriga, R. (2006) Una nueva especie de pez del género *Hemibrycon* (Characiformes: Characidae). *Revista de Biología Tropical*, 54(1), 209–217.
- Ruiz-Calderón, R. & Román-Valencia, C. (2006) Osteología de *Astyanax aurocaudatus*, Eigenmann, 1913 (Pisces: Characidae), con notas sobre la validez de *Carlastyanax*, Géry, 1972. *Animal Biodiversity and Conservation*, 29(1), 49–51.
- Song, J. & Parenti, L. (1995) Clearing and staining whole fish specimens for simultaneous demonstration of bone, cartilage and nerves. *Copeia*, 1995, 114–118.
- Taylor, W. & VanDyke, G. (1985) Revised procedures for staining and clearing small fishes and other vertebrates for bone and cartilage study. *Cybium*, 9, 107–119.
- Ulrey, A. (1894) Preliminary descriptions of some new South American Characinidae. *American Naturalist*, 610–611.
- Vari, R. (1995) The neotropical fish family Ctenoluciidae (Teleostei: Ostariophysi: Characiformes) supra and intrafamilial phylogenetic relationships, with a revisionary study. *Smithsonian Contribution to Zoology*, 564, 1–96.
- Weitzman, S. (1977) A new species of characid fish, *Hyphessobrycon diancistrus*, from the Río Vichada, Orinoco river drainage, Colombia, South America (Teleostei: Characidae). *Proceedings of the Biological Society of Washington*, 90(2), 348–357.
- Weitzman, S. & Fink, W. (1983) Relationships of the neon tetras, a group of South American freshwater fishes (Teleostei, Characidae), with comments on the phylogeny of New World Characiformes. *Bulletin of Museum of Comparative Zoology*, 150, 339–395.
- Weitzman, S.H. & Palmer, L. (1997). A new species of *Hyphessobrycon* (Teleostei: Characidae) from the Neblina region of Venezuela and Brazil, with comments on the putative, rosy tetra clade. *Ichthyological Exploration of Freshwaters*, 7(3), 209–242.
- Weitzman, S.H. & Malabarba, L.R. (1998) Perspectives about the Phylogeny and Classification of the Characidae (Teleostei: Characiformes). In: Malabarba, L. R., Reis, R.E., Vari, R.P., Lucena, Z. M. S. & Lucena, C.A.S., (Eds). *Phylogeny and Classification of Neotropical Fishes*. Porto Alegre: EDIPUCRS, 161–169.
- Weitzman, S.H. & Malabarba, L.R. (1999) Systematics of *Spintherobolus* (Teleostei: Characidae: Cheirodontinae) from eastern Brazil. *Ichthyological Exploration of Freshwaters*, 10, 1–43.