

Redescription of *Hyphessobrycon flammeus* Myers, 1924 (Ostariophysi: Characidae), a threatened species from Brazil

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One of the most gorgeous colored and endangered *Hyphessobrycon* species, *H. flammeus* Myers, is redescribed. Diagnostic characters of the species are two vertically elongated humeral spots, no caudal peduncle blotch, 5-8 maxillary teeth, caudal fin hyaline, and longitudinal dark stripe of the body absent. Sexual dimorphism is present, with males being more colored than females and having bony hooks in the anal and pelvic fins, which are dark in their terminal portions. Comments about its occurrence in the upper rio Tietê drainage (upper rio Paraná basin), its conservation status, and the phylogenetic position into Characidae context are also presented.

Uma das mais coloridas e ameaçadas espécies de *Hyphessobrycon*, *H. flammeus*, é redescrita. Caracteres diagnósticos para a espécie são duas máculas umerais verticalmente alongadas, mancha no pedúnculo caudal ausente, presença de 5-8 dentes no maxilar, nadadeira caudal hialina e faixa negra longitudinal no flanco ausente. A espécie apresenta dimorfismo sexual, com machos mais coloridos que as fêmeas e com ganchos ósseos nas nadadeiras anal e pélvica; além disso, as extremidades destas nadadeiras são enegrecidas. Comentários sobre a distribuição da espécie na drenagem do alto rio Tietê (bacia do alto rio Paraná), seu status de conservação e posição filogenética no contexto de Characidae são também apresentados.

Key words: Characiformes, Engraçadinho, Flame tetra, Coastal streams, Endangered species.

Introduction

Hyphessobrycon Durbin is one of the richest genus of Characidae, with more than 130 species, many described in this century (e.g., Lima & Moreira, 2003; Carvalho & Bertaco, 2006). Besides this diversity, several species need to be revised and compared with its congeners and with all other small Characidae, because to date they fail to be clearly and unequivocally distinguished from other congeners. The boundary of diagnostic characteristics for the genus is wide (see Durbin in Eigenmann, 1908; Eigenmann, 1917, 1918), and some species present other characteristics added to the genus after Eigenmann (1917, 1918) (e.g., complete lateral line, absent adipose fin) that should be analyzed in a more inclusive context.

In Brazil, there are three threatened species of *Hyphessobrycon*: *Hyphessobrycon duragenys* Ellis, *H. flammeus* Myers, and *H. taurocephalus* Ellis (Lima & Moreira, 2008). All these species are poorly described, their distribution

is uncertain, and limited data are available in the literature about biology/ecology and distribution.

Hyphessobrycon flammeus is a small, brightly colored tetra, which is very appreciated in aquarium trade. The species was described by Myers (1924) from some aquarium specimens that had been identified as *H. bifasciatus* Ellis (known as 'red *Tetragonopterus* from Rio'). Since its original description, little taxonomic information was added for the taxon in literature. As mentioned above, *H. flammeus* composes the list of Brazilian freshwater fish endangered species (Machado *et al.*, 2005; Lima & Moreira, 2008). This situation requires efforts to understand its identity, geographic distribution, and ecological/biological data, necessary for the establishment of public policies to its effective conservation.

Herein we present a redescription of *H. flammeus*, with details about its geographical distribution and comments about its phylogenetic relationships in the Characidae context (*sensu* Mirande, 2010).

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Material and Methods

Measurements and counts followed Fink & Weitzman (1974), Lima & Moreira (2003), and Carvalho *et al.* (2010). Measurements were made with a caliper rule to the nearest 0.05 mm on the left side of the specimen whenever possible, and are presented as percents of standard length (SL) or head length (HL). In the description, counts are followed by their frequency in parentheses, and asterisk(s) indicates the count of the syntype(s). In the list of examined material, the number of all specimens in the lot is followed by the number of those examined and cleared and stained (c&s) individuals, if any. Counts for vertebrae, supraneurals, gill-rakers on the first branquial arch, branchiostegal rays, procurrent caudal-fin rays, and small dentary teeth were taken from six c&s specimens prepared according to Taylor & Van Dyke (1985). Vertebral count included the four vertebrae in the Weberian apparatus and the fused PU1+U1 of the caudal region as a single element. The pattern of *circuli* and *radii* was defined on scales sampled from the region between the lateral line and the insertion of pelvic-fin. Comparisons and data of species not available for examination were taken from the literature (original descriptions). Catalog numbers are followed by the total number of specimens, number of specimens measured and counted in parentheses, and SL range of all specimens of the lot. Comparative material examined included also those material listed in Carvalho & Langeani (2013).

Institutional abbreviations followed Reis *et al.* (2003), with addition of Laboratório de Biologia e Genética de Peixes, Departamento de Morfologia, Instituto de Biociências, Universidade Estadual Paulista, Botucatu, São Paulo, Brazil (LBP).

A phylogenetic analysis was performed, using TNT software (Goloboff *et al.*, 2008), adding *Hyphessobrycon flammeus* to the matrix of Mirande (2010) and modified by Malabarba *et al.* (2012). The analysis included implied weighting, following the same procedures described by Mirande (2009, 2010), and 21 values of “k” were used under each of the weighting schemes. Character states for *H. flammeus* are given in Table 1. The numbers given for the characters followed Mirande (2010). Cytogenetic data (characters 361-365) were of Arefjev (1990).

Results

Hyphessobrycon flammeus Myers, 1924

Figs. 1-5

Hyphessobrycon flammeus Myers, 1924: 330-331. Type locality: Rio de Janeiro, Brazil. -Géry, 1977: 458 (classification in artificial group b); 463 (key for the species); 465 (image). -Weitzman & Vari, 1988: 447; 450 (listed as miniature species). -Weitzman *et al.*, 1988: 419-420 (notes about geographic distribution and biogeography). -Mazzoni *et al.*, 2000: 66 (citation for areas of occurrence - fluvial lowland and marsh). -Lima *et al.*, 2003: 137 (check list for the genus). -Lima & Moreira, 2008: 72-73 (threatened species in Brazil, category EN - A2ace; B2ab(iii); historic and biology notes; additional notes about geographic distribution, biogeography and conservation strategies). -Oyakawa *et al.*, 2009: 366 (listed as threatened for São Paulo State, category EN B2abiii; comments about distribution, ecological notes). -Marceniuk *et al.*, 2011: 221; 223-225; 232; 235 (listed).

Diagnosis. *Hyphessobrycon flammeus* differs from its congeners (except *H. bifasciatus*, *H. balbus* Myers, *H. chocoensis* García-Alzate, Román-Valencia & Taphorn, *H. columbianus* Zarske & Géry, *H. condotensis* Regan, *H. griemi* Hoedeman, *H. igneus* Miquelarena, Menni, López & Casciotta, *H. itaparicensis* Lima & Costa, *H. panamensis* Durbin, *H. savagei* Bussing, *H. sebastiani* García-Alzate, Román-Valencia & Taphorn, *H. tortuguerae* Böhlke, and *H. weitzmanorum* Lima & Moreira) by presenting two humeral spots vertically elongated and no caudal peduncle blotch. *Hyphessobrycon flammeus* differs from aforementioned species by presence of 5-8 maxillary teeth (*vs.* 1-3 in *H. balbus*, 1-2 in *H. bifasciatus* and *H. igneus*, 3 in *H. condotensis* and *H. panamensis*, 2-3 in *H. griemi*, 1-4 in *H. savagei*, 2 in *H. chocoensis* and *H. sebastiani*, 9-10 in *H. tortuguerae*), caudal fin hyaline (*vs.* caudal fin with black median stripe in *H. weitzmanorum*), no longitudinal stripe dark and second humeral spot conspicuous as well as first humeral spot (*vs.* faint longitudinal stripe dark and second humeral spot less defined than first in *H. weitzmanorum*).

Description. Morphometric data are summarized in Table 2. Body compressed, moderately short, greatest body depth at vertical through dorsal-fin origin. Dorsal profile of head convex from tip of upper jaw to vertical through anterior nostril; slightly straight or concave from that point to tip of

Table 1. Character states of *Hyphessobrycon flammeus*. Character list is the same of Mirande (2010); polymorphisms [01] are represented as “a”.

00110010-1	0011000100	0001100001	0010100100	0000011000	0110000100	00a10010-1	-0100---00
0010000110	10-100000a	001--00000	1000000100	01000111a0	0001110100	001-00a000	1010000000
0a00000201	0001000110	0101000001	00011a0000	1-11000010	0100000101	0100010100	1000000000
0000000001	0111000a00	0001100001	100001000a	0000111a00	0000010101	0000001110	0000000011
2000000010	0101110000	0100000000	0000?00???	11100			



Fig. 1. *Hyphessobrycon flammeus*, USNM 92969, syntype, 25.6 mm SL, vicinity of Rio de Janeiro, Rio de Janeiro State, Brazil. Scale bar = 2 mm. Photo by Sandra Raredon.



Fig. 2. *Hyphessobrycon flammeus*, LBP 8905, upper rio Tietê drainage, Biritiba Mirim, São Paulo State: (a) male, 19.1 mm SL (with a cyst nematode on upper lobe of caudal-fin), and (b) female, 20.1 mm SL. Scale bars = 2 mm.

Table 2. Morphometric data for *Hyphessobrycon flammeus*. SD = standard deviation, including the syntypes data (N = 2); range is of non-types specimens; N = number of specimens, not including the syntypes.

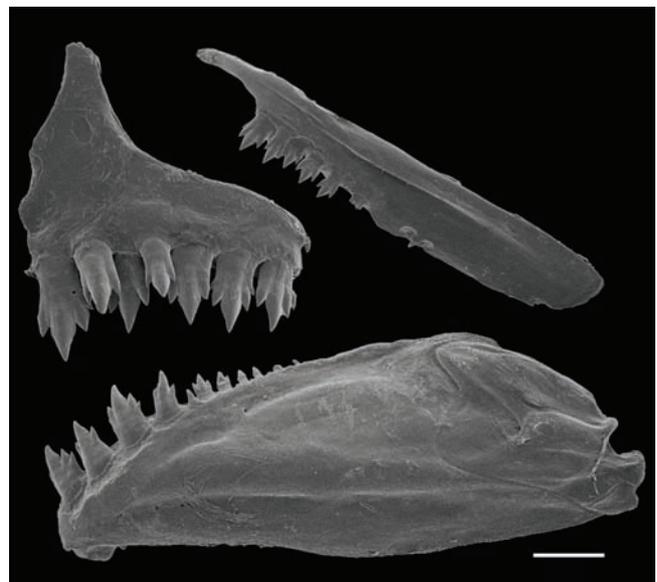
	Syntypes	Range	Mean	SD	N
Standard Length (mm)	24.1-25.4	11.2-26.1	18.7	-	68
Percents of Standard Length					
Body depth	37.5-41.0	35.7-43.6	38.7	2.2	68
Head length	27.1-27.2	21.3-31.4	24.0	1.8	68
Head depth	32.9-34.4	24.9-33.9	31.6	1.7	68
Predorsal length	49.3-49.3	45.6-53.8	49.9	2.1	68
Prepelvic length	45.0-48.1	40.0-48.1	43.4	1.9	68
Pelvic fin to anal distance	14.2-15.7	12.1-17.7	14.2	1.4	68
Caudal peduncle depth	12.3-13.1	9.3-15.3	10.9	1.2	68
Dorsal-fin base length	15.1-15.1	12.8-18.1	14.7	1.3	68
Anal fin base length	32.8-36.4	30.3-38.3	35.1	1.9	68
Pectoral-fin length	20.6-21.1	17.1-24.8	20.5	1.7	68
Pelvic-fin length	18.2-18.4	14.1-18.8	17.0	1.1	68
Dorsal-fin length	29.0-30.1	26.0-35.2	30.6	2.2	65
Anal-fin length	23.0-25.2	17.9-24.5	20.3	1.3	55
Caudal peduncle length	13.6-14.1	10.1-16.8	13.1	1.7	67
Dorsal fin to adipose-fin distance	42.4-43.7	37.4-44.1	40.5	1.8	67
Eye to dorsal-fin origin	35.9-36.0	32.7-38.7	35.9	1.7	68
Dorsal origin to caudal origin	56.7-58.5	50.1-59.2	53.9	1.8	67
Percents of Head Length					
Interorbital width	34.2-34.3	31.5-37.8	35.5	1.6	68
Snout length	24.1-24.5	20.1-27.3	23.2	1.8	68
Orbital diameter	42.7-44.1	41.2-47.8	45.6	1.6	68
Upper jaw length	42.9-44.5	40.4-48.0	43.4	1.7	68

supraoccipital spine. Dorsal profile of body slightly convex from posterior tip of supraoccipital spine to base of last dorsal-fin ray, and straight to adipose-fin origin; last dorsal-fin ray at vertical through of anal-fin base. Ventral profile of body convex from tip of lower jaw to pelvic-fin origin, straight or slightly convex from that point to anal-fin origin, and straight and/or subtly rounded along anal-fin base. Dorsal and ventral profiles of caudal peduncle slightly straight.

Eyes relatively large compared with head, without distinct adipose eyelid. Lower jaw slightly longer than upper jaw, mouth slightly subterminal. Maxilla extending posteriorly surpassing anterior margin of orbit to vertical through crystalline lens anterior margin, slightly curved, aligned approximately at 45 degrees angle relative to longitudinal axis of body. Nostrils close to each other, anterior opening small and circular, posterior one twice in size and slightly reniform or elongate. Nostrils separated by skin flap. Nasal bone absent. Frontals separated anteriorly, with wide fontanel; parietal fontanel large, extending from epiphyseal bar to supraoccipital spine, slightly narrowed anteriorly. Infraorbital series with four or five elements (probably fifth and sixth, when present, fused). Laterosensorial canal of first infraorbital absent, from second to fourth canal close to inner margin of orbital rim. Third infraorbital largest, double size compared to other (in length and depth) and contacting laterosensory canal of preopercle ventrolaterally.

Premaxillary teeth in two rows: outer row with 1*(12) or 2(46) tricuspid teeth; inner row with 5*(57) or 6(1) pentacuspid teeth. Dentary with 4*(59) or 5(1) large, tri- to

pentacuspid teeth, followed by 4(1), 5(14), 6(38), 7(6), or 8(1) small, conical or tricuspid, teeth abruptly smaller than anterior largest teeth. Dorsal border of maxilla relatively straight. Maxilla with 5*(35), 6(13), 7(10), 8(4), or 9(1) conical, tri- to pentacuspid teeth along anteroventral margin (Fig. 3). Central median cusp of all teeth longer than remaining lateral cusps; cusp tips slightly curved inward on dentary teeth, and relatively straight on premaxillary teeth.

**Fig. 3.** *Hyphessobrycon flammeus*, MZUSP 90292, 22.0 mm SL, scanning electronic micrograph of lower and upper jaws, left side. Scale bar = 0.3 mm.

Scales cycloid, with few and relatively small *radii* (3-7); *circuli* marked anteriorly and marginally (dorsal and ventral). Lateral line incomplete, extending to vertical through middle of pectoral fin; perforated scales 4*(23), 5*(24), or 6(9); longitudinal scales series including pored scales 26(8), 27(1), 28(17), 29(6), 30*(15), 31(4), 32(1), 33*(4), or 34(2); five*(52) or six*(6) scale rows between dorsal-fin origin and lateral line; five*(3) or six*(55) scale rows between lateral line and pelvic-fin origin. Predorsal scales 6(1), 7(1), 8*(27), 9*(14), or 10(15). Scale sheath along anal-fin base in single row of 4(13), 5*(25), 6(11), or 7(6) scales. Circumpeduncular scales 14*(47) or 15(6). Axillary scale absent.

Dorsal-fin rays ii,9*(62) or 10(3); first unbranched ray approximately one-half of second one or shorter. Dorsal-fin origin at midbody or posterior, at vertical through anterior third of pelvic fin base. Base of last dorsal-fin ray at vertical through distal tip of pelvic fin, anterior to origin of anal fin. Tip of longest ray of adpressed dorsal fin at vertical through base of first two branched anal-fin rays. First dorsal-fin pterygiophore inserting between neural spine of 10th(1) and 11th(3) precaudal vertebra. Adipose fin present. Pectoral fin with i,9*(2), 10*(40), or 11(11) rays, extending to pelvic fin origin. Pelvic fin with i,6*(43) or 7(22) rays; its origin anterior to vertical through dorsal-fin origin; tip of rays reaching anal-fin origin. Anal-fin rays iv,20(1), 21(3), 22*(11), 23(15), 24(21), or 25(8). Anal fin of males with small bony hooks. Caudal fin forked, lobes slightly rounded, similar in size, i,9/7,i (2), i,9/8,i*(41), or i,10/8,i (1) [one specimen with i,5/5,i, probably anomalous] rays. Caudal fin naked, scales restricted to its base. Dorsal procurrent caudal-fin rays 8(2) or 9(2) and ventral procurrent caudal-fin rays 7(1) or 8(3).

Branchiostegal rays 4. First gill arch with 6(3) or 7(1) gill rakers on epibranchial, 1(4) between epibranchial and ceratobranchial, 8(3) or 9(1) on ceratobranchial, and 2(4) on hypobranchial. Precaudal vertebrae 13(2) or 14(2) and caudal vertebrae 17(1), 18(2), or 19(1); total vertebrae 31(1) or 32(3). Supraneurals 4(2) or 5(2), filiform, some with dorsal portion expanded.

Color in alcohol. Overall body color yellowish to whitish. Dark chromatophores scattered on the lateral portion of head,

more densely concentrated from snout to the supraoccipital. Second and third infraorbitals and upper region of opercular apparatus denser chromatophores, and yellowish adjacent areas. Small chromatophores scattered on the jaws. Two conspicuous vertically elongated humeral spots, extending from the dorsal portion to the pectoral fin, positioned over three to four vertical series of scales above the lateral line and four to five below it, and vertically extending over two to four horizontal series of scales, more intense in the middle of the humeral spot; both spots are separated by two to three horizontal scales. Abdominal region yellowish, with few scattered chromatophores. Lateral side of the body scattered melanophores, dorsal portion with a reticulated pattern on the posterior margin of its scales. Midlateral body stripe absents. All fins hyaline or slightly dark (see more details for males in sexual dimorphism).

Color in life. Overall, body with an intense reddish color (hence the name *flammeus*, from latin, red - flame-colored). More intense concentration of erythrophores between verticals from the dorsal and/or pelvic-fin to anal-fin end. Distribution of melanophores on its head, flank and fins similar to the one described in alcohol coloration. Dorsal and dorsolateral regions of body rosaceous and orangish. Ventral area of its head up to its posterior humeral spot, including the abdominal region, slightly grayish to yellowish. Sometimes, the upper area of its head up to its first humeral spot with iridescent blue hues. All fins reddish, no pigmentation on the middle caudal-fin rays; caudal and anal fins with a more intense color. Males with black pelvic and anal fins tips and whitish dorsal fin (*vs.* absent in females) (Fig. 4).

Sexual dimorphism. Males of *Hyphessobrycon flammeus* present bony hooks in the anal and pelvic fins (Fig. 5) (*vs.* absent in females). Small, simple bony hooks in the anal fin, extending from the last unbranched ray to the last branched rays, *i.e.*, in all fin rays (Fig. 5a for the first bony hooks in the anal fin); pelvic fin with hooks in the first two or three branched rays (Fig. 5b). Distal portion of its anal fin slightly straight in males (*vs.* anteriorly falcate in females) (Fig. 2).

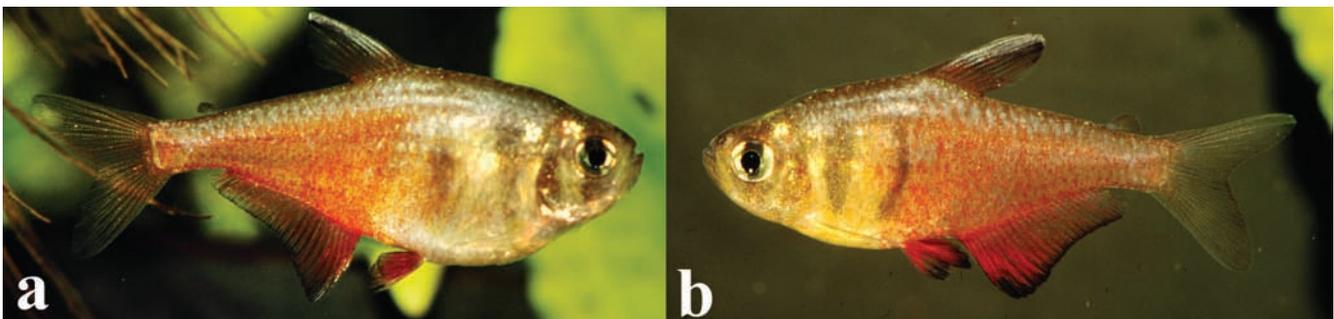


Fig. 4. *Hyphessobrycon flammeus*, live specimens of (a) female and (b) male. Photos and copyrights by Peter Hoffmann and Martin Hoffmann..

Males normally smaller than females, but present a bright reddish color, with black tips on pelvic and anal fins. Darkish dorsal fin in the middle portion and whitish on the tip in both males and females. Gill glands (Burns & Weitzman, 1996) were not found macroscopically on first gill arch on both sexes.

Distribution. *Hyphessobrycon flammeus* has occurrence in streams and coastal rivers of Rio de Janeiro State, in Guanabara bay basin, middle rio Paraíba do Sul basin and rio Guandu basin. In the upper rio Tietê drainage (upper rio Paraná basin, São Paulo State) it is found around of the metropolitan region of São Paulo city (Fig. 6).

Ecological notes. *Hyphessobrycon flammeus* has been reported in small streams of slow flowing, dark-brown or clear water, shaded by small forest (Myers, 1944). Recently, it has been found in upper rio Tietê drainage, in small streams of clear water and sandy bottom, as well as in the marginal portions of rio Tietê (Lima & Moreira, 2008).

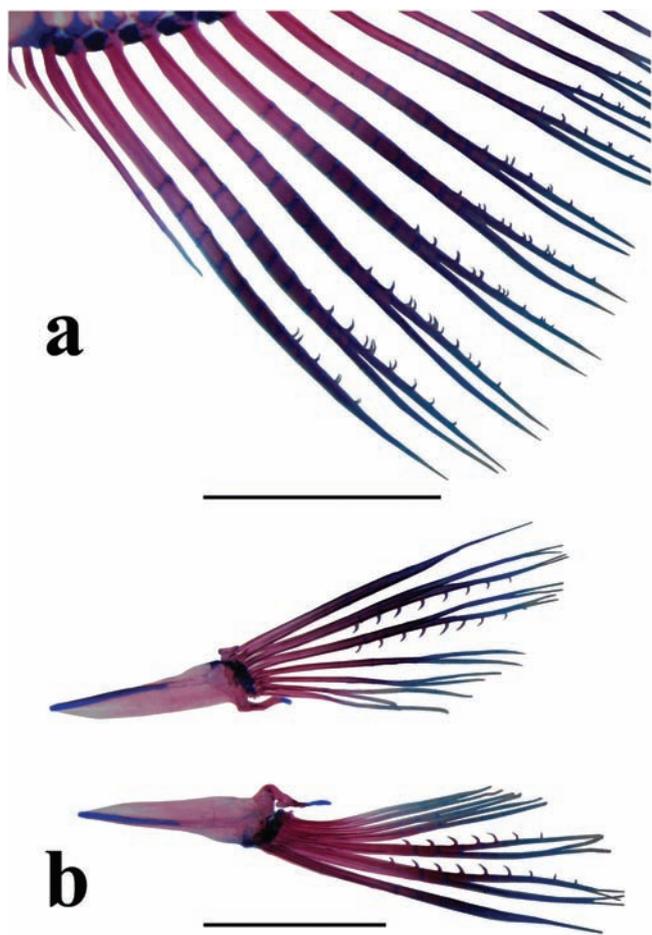


Fig. 5. *Hyphessobrycon flammeus*, MZUSP 90292, 22.0 mm SL, bony hooks in (a) anterior portion of anal-fin rays and (b) in the two first branched pelvic-fin rays.

Life expectancy is around four years. In its natural habitat it forms relatively numerous schools with agonistic interaction among alpha males. The species prefer environments with vegetation and streams with slow flowing water, living in depths not superior to 50 cm, and water temperature from 22°C to 28°C. Its diet includes small insects, ‘worms’, and plants (Miranda *et al.*, 2012). The c&s stomach contents of four specimens contained aquatic insects, mainly Chironomidae larvae, and fine organic matter.

During reproduction, the female deposits around 200 to 330 oocytes on rocks, plants, or submerged debris; after that, the male releases the sperm for fecundation. The eggs hatch in approximately 2-3 days (Miranda *et al.*, 2012). Further ecological/biological information can be found in Myers (1924, 1945), Lima & Moreira (2008) and Oyakawa *et al.* (2009). On the Wide World Web, there is plenty of information shared among aquarists about behavior, reproduction, and many other biological characteristics of *H. flammeus*, including information on keeping and reproducing them in captivity.

Conservation remarks. *Hyphessobrycon flammeus* has been in the Brazilian list of threatened fish species since 2004 (Diário Oficial da União, 2004), category EN-A2ace; B2ab(iii) (*i.e.*, endangered species). However, after the last evaluation conducted by ICMBio (Instituto Chico Mendes de Conservação da Biodiversidade) (in 2012, unpublished data) the category EN will be maintained, but the criteria will be changed.

Notwithstanding its relative abundance in upper rio Tietê drainage streams, it is not common in the region of Rio de Janeiro State as referred in the material which was examined herein and mentioned by Lima & Moreira (2008). Therefore, in order to preserve its original population, it will continue as a threatened species, and public policies should prioritize its maintenance and conservation.

Popular names. Due to its popularity in the aquarium trade, *Hyphessobrycon flammeus* is known by many different names in the world, such as ‘engraçadinho’, ‘lambarizinho vermelho’, ‘Rio tetra’, ‘tetra-rio’, ‘tetra-rosa’, ‘tetra-vermelho’, and ‘vermelhinho’ (Brazil), flame tetra (USA and Philippines), ‘ognennaya tetra’ (Russian Federation), ‘punatetra’ (Finland), ‘red tetra’ (USA), ‘rød Rio’ (Denmark), ‘roter von Rio’ (Germany) (Lima & Moreira, 2008; Froese & Pauly, 2013).

Phylogenetic reconstruction. Phylogenetic analysis, according to implied weighting procedures (Miranda, 2009, 2010), with consensus of “k” = 9.99804 (three trees) and “k” = 10.97824 (three trees) values, resulted in one tree with 2209 steps, consistency index (CI) of 0.17 and retention index (RI) of 0.66.

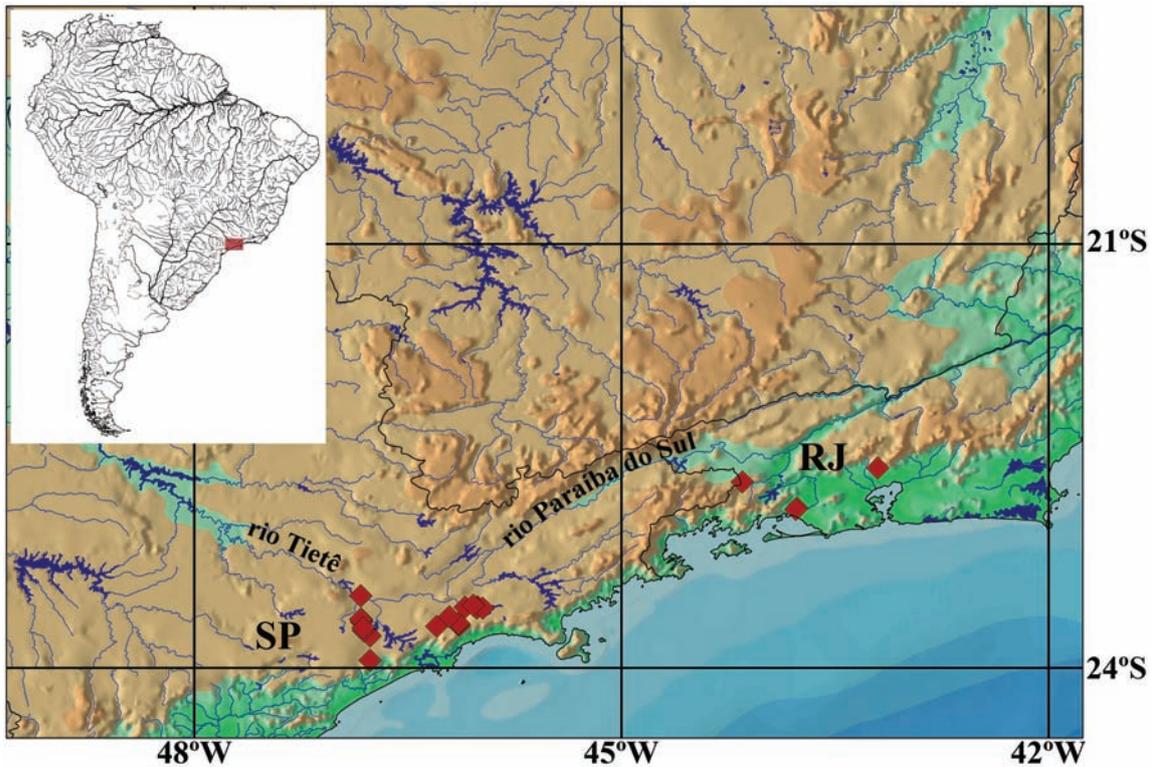


Fig. 6. Geographic distribution of *Hyphessobrycon flammeus* in the Rio de Janeiro and São Paulo States. Some symbols can represent more than one lot or locality.

In this hypothesis, *H. flammeus* is the basal species of the clade 196 of Mirande (2010), *i.e.*, (*H. flammeus* ((Aphyocharacinae (Aphyoditeinae, Cheirodontinae)) Stevardiinae)). Synapomorphies for this clade are: **ch. 53:1** - length of supraoccipital spine extends only to anterior limit of neural complex; **ch. 266:0** - two dorsal-fin rays articulating with first dorsal pterygiophore; **ch. 363:1** - number of 2n chromosomes, 52 or more. Autapomorphies for *H. flammeus* are: **ch. 33:1** - nasal bone absent; **ch. 58:1** - bony lamellae bordering laterosensory canal of first infraorbital absent; **ch. 99:0** - posterior extent of maxilla not reaching second infraorbital; **ch. 168:2** - foramen in posterior region of metapterygoid in form of incomplete arch, bordered posteriorly by hyomandibula; **ch. 201:1** - denticles on gill rakers absent; **ch. 253:1** - position of ventral end of posttemporal posterior to lateral margin of epioccipital; **ch. 305:0** - anterior ventral procurrent caudal-fin rays paired, only distally fused; **ch. 332:1** - posterior attachment of A1 section of *adductor mandibulae* restricted or almost restricted to horizontal arm of preopercle; **ch. 342:1** - second humeral spot present as a conspicuous vertical bar.

Examined material. Syntypes. USNM 92969, 2(2), 24.1-25.4 mm SL, Brazil, Rio de Janeiro State, vicinity of Rio de Janeiro, R. Brooca [probable], aquarium bred, no date. **Non-types: All from Brazil. Rio de Janeiro State: Guanabara bay basin.** MNRJ 8795, 16, 8.6-19.2 mm SL, floodplain near to Imbariê, Baixada Fluminense, L. Travassos, H. S. Lopes & H. Travassos,

04 Aug 1954. **Middle rio Paraíba do Sul basin.** MNRJ 19543, 20, 14.3-17.1 mm SL, 47 older road Rio-São Paulo, 15 Dec 1972. **Rio Guandu basin:** MZUSP 51020, 1(1), 17.8 mm SL, Itaguaí, ribeirão da Ponte do Teixeira, on road Itaguaí/Raiz da Serra, Km 5, 08 Sep 1969. ZUEC 4253, 7, 15.7-20.4 mm SL, Itaguaí, 15 Dec 1972. **São Paulo State: rio Tietê drainage, upper rio Paraná basin.** LBP 8890, 1(1), 21.0 mm SL, Salesópolis, rio Tietê, 10 Sep 2009. LBP 8905, 31 of 45 (31), 16.6-21.8 mm SL, Biritiba Mirim, rio Tietê, 10 Sep 2009. MCP 20235, 1, 19.5 mm SL, Mogi das Cruzes, Tietê, rio Taiaçupeba near electric plant of Tijuco Preto in Taiaçupeba, 12 Jan 1997. MCP 20237, 7 of 15, 13.2-20.9 mm SL, Biritiba Mirim, first stream in road from Biritiba Mirim to Casa Grande, 13 Jan 1997. MCP 20239, 3, 18.9-20.8 mm SL, Mogi das Cruzes, stream on road of Mogi das Cruzes to Salesópolis, ca. 8 km of Mogi das Cruzes, 13 Jan 1997. MCP 25545, 2, 15.5-25.4 mm SL, Biritiba Mirim, Mogi das Cruzes, stream on road to Biritiba Mirim/Casa Grande, affluent of Ponte Nova Dam in the rio Tietê, 17 Dec 1999. MNRJ 39230, 1, 26.9 mm SL, Mogi das Cruzes, district of Natureza de Taiaçupeba, headwater of rio Grande, 07 Nov 2011. MNRJ 39235, 21, 14.2-29.4 mm SL, Mogi das Cruzes, stream tributary of rio Jundiá together junction of road for fazenda rio Grande with municipal road Taiaçupeba-Bertioga, 07 Nov 2011. MNRJ 39240, 31, 11.8-23.6 mm SL, Mogi das Cruzes, headwaters of rio Jundiá, fazenda do Sr. Celso Meida, 07 Nov 2011. MZUSP 86925, 6 of 7 (6), 16.2-18.2 mm SL, Biritiba Mirim, in the area of VCN Mining, 21 Mar 2005. MZUSP 88175, 1(1), 12.6 mm SL, Embu, stream affluent of rio

Embu with empties in reservoir of Guarapiranga, 23 Aug 2005. MZUSP 88183, 17, 14.0-24.4 mm SL, Itapecerica da Serra, stream affluent of rio Embu-Mirim, near deposit of construction material Lagoa, on road João Rodrigues de Morais, 23 Aug 2005. MZUSP 88190, 1(1), 13.5 mm SL, Itapecerica da Serra, stream affluent of rio Embu-Mirim, on road João Rodrigues de Morais, Lagoa neighborhood, 23 Aug 2005. MZUSP 88198, 1(1), 17.1 mm SL, Itapecerica da Serra, stream affluent of rio Embu-Mirim, Lagoa neighborhood, 23 Aug 2005. MZUSP 88207, 19 (10, 1 c&s, 11.2-19.6 mm SL), 9.6-19.6 mm SL, stream affluent of Guarapiranga dam, on road of Jaceguava, near soccer stadium, Casa Grande neighborhood, 24 Aug 2005. MZUSP 90285, 28, 12.7-21.0 mm SL, São Paulo, Embu, stream affluent of rio Embu, 25 Mar 2006. MZUSP 90292, 31 (10, 2 c&s, 17.5-26.1 mm SL), 17.5-26.1 mm SL, Embu, stream affluent of rio Embu-Mirim, near deposit of construction material Lagoa, on road João Rodrigues de Morais, 25 Mar 2006. MZUSP 90309, 14, 11.4-22.3 mm SL, São Paulo, stream affluent of Guarapiranga dam, on road of Jaceguava, near soccer stadium, 26 Mar 2006. MZUSP 95314, 34, 16.8-22.7 mm SL, Embu, ribeirão Embu (lowland), 29 Aug 2007. MZUSP 99700, 54, 14.6-28.7 mm SL, Embu, stream affluent of Ribeirão Embu-Mirim, stake 34101 of lot 5 Rodoanel Mário Covas (upstream), 21 May 2008. MZUSP 101342, 2, 20.4-20.7 mm SL, Itapecerica da Serra, ribeirão Itaquaxiara, affluent of rio Embu-Mirim, near road of Pedreira, Lagoa neighborhood, 18 Nov 2008. MZUSP 101345, 46, 14.8-21.9 mm SL, Embu, stream affluent of rio Embu-Mirim, stake 34101 of lot 5 Rodoanel Mário Covas, 02 Feb 2009. MZUSP 102799, 3, 19.9-21.7 mm SL, Biritiba Mirim, in the area of VCN Mining, 13 Mar 2009. MZUSP 102803, 5, 17.0-17.8 mm SL, São Paulo, Biritiba Mirim, Tietê, rio Tietê, in the area of VCN Mining, 13 Mar 2009. MZUSP 109043, 26, 11.2-16.5 mm SL, Itapecerica da Serra, ribeirão Itaquaxiara, affluent of rio Embu-Mirim, near road of Pedreira, Lagoa neighborhood, 21 Aug 2009. MZUSP 109046, 2, 18.4-23.0 mm SL, Itapecerica da Serra, ribeirão Itaquaxiara, affluent of rio Embu-Mirim, near road of Pedreira, Lagoa neighborhood, 06 Nov 2009. MZUSP 109052, 46, 9.9-21.0 mm SL, Embu, stream affluent of ribeirão Embu-Mirim, stake 34101 of lot 5 Rodoanel Mário Covas (upstream), 06 Apr 2009. MZUSP 109053, 29, 12.8-22.9 mm SL, Embu, stream affluent of ribeirão Embu-Mirim, stake 34101 of lot 5 Rodoanel Mário Covas (upstream), 19 Dec 2008. MZUSP 109054, 17, 10.7-16.6 mm SL, Embu, stream affluent of ribeirão Embu-Mirim, stake 34101 of lote 5 Rodoanel Mário Covas (upstream), 15 Sep 2009. MZUSP 109055, 16, 17.8-24.5 mm SL, Embu, stream affluent of ribeirão Embu-Mirim, stake 34101 of lot 5 Rodoanel Mário Covas (upstream), 19 Marc 2009. MZUSP 111018, 11, 14.3-20.5 mm SL, São Paulo, rio Embu-Guaçu, 04 Apr 2012. ZUEC 3560, 9, 12.1-18.3 mm SL, Mogi das Cruzes, Taiapuêba, 18 Feb 1978. ZUEC 4439, 10, 13.7-20.2 mm SL, Mogi das Cruzes, rio Jundiá, I. Sazima & M. Sazima, 21 Jul 1977. ZUEC 4624, 10, 10.8-22.2 mm SL, same locality as ZUEC 3560. **Indeterminate locality:** MHNG 857.64, 1, 27.7 mm SL, aquarium probably, no

date. MHNG 2178.79, 2, 23.6-23.8 mm SL, aquarium, Zoology Museum Copenhagen, Apr 1970. MHNG 2178.077, 2, 22.5-26.0 mm SL, aquarium, 1958. MHNG 2742.088, 6, 15.8-20.4 mm SL, aquarium specimens, 24 Feb 1961. MZUSP 87148, 11 (6, 1 c&s, 18.2-20.0 mm SL), 16.5-20.0 mm SL, aquarium, no date.

Discussion

Hyphessobrycon flammeus is a small-sized species from a non-monophyletic and heterogeneous genus (*cf.* Zanata & Camelier, 2011, Ingenito *et al.*, 2013). The artificial classification presented by Géry (1977) is a convenience to group the species in the genus according to the color pattern, but not expressing the common ancestry of all taxa currently housed in *Hyphessobrycon*.

The combination of diagnostic characteristics from *H. flammeus*, *i.e.*, 5-8 teeth in maxilla, two humeral spots and no caudal peduncle spot, associated with the bright reddish color of its body seems to be unique among the *Hyphessobrycon* species. Due to this color pattern, it is a very appreciated species in aquarium trade.

Some characters presented by *H. flammeus*, *e.g.*, incomplete lateral line, infraorbital series with fused elements, small size (up to 26.1 mm SL), absent nasal bone, are reductive characters which characterize miniature species (*sensu* Weitzman & Vari, 1988). The reductive characters can influence its position in the cladogram far from other *Hyphessobrycon*, which do not normally present these conditions. As presented by Mattox *et al.* (2013), reductive characters are potential sources of problem in phylogenetic hypothesis, because they could be derived from different events of miniaturization, resulting in false synapomorphies to clades or autapomorphies to taxa.

The phylogenetic analysis showed that *Hyphessobrycon flammeus* is not close to *H. compressus*, the type species of genus. In this present analysis, the relationship for *H. compressus* is (*Hyphessobrycon compressus* (*Hemigrammus unilineatus*, *Pristella maxillaris*) (*Hyphessobrycon pulchripinnis* (*Hyphessobrycon eques*, *Hyphessobrycon socolofi*))). Although it is clear the polyphyly of *Hyphessobrycon* and the removal necessity of many species currently housed in this genus, taxonomic changes involving all taxa are expected only after a careful analysis including most species of the genus. So, we keep the species in the genus until these changes are implemented.

Distribution of *Hyphessobrycon flammeus* was mentioned in the literature, until around 2007, as restricted to the coastal rivers of Rio de Janeiro State (Lima *et al.*, 2003). Lima & Moreira (2008) expanded the distribution to São Paulo State in upper rio Tietê drainages, discussing the uncertainty of being autochthonous or allochthonous in the upper rio Paraná basin. Despite these two different populations, coastal and upper rio Paraná, no significant differences between them were found.

The first record of *H. flammeus* to upper rio Tietê basin is from 1977 (ZUEC 4439). Natural occurrence of the same species in two isolated basins (*i.e.*, coastal drainages and upper rio Tietê) has been widely documented in the literature since Langeani (1989), as well as by Ribeiro *et al.* (2006), Serra *et al.*, (2007), Silva *et al.* (2010), and Marceniuk *et al.* (2011). Despite this evidence, this does not seem to be the case for the *H. flammeus* distribution.

The recent record of *Hyphessobrycon flammeus* in upper rio Tietê drainage strongly suggests that it is, very likely, arising from the introduction by aquarium trade. Some facts which support this hypothesis are: i. the species has always been common in the aquarium trade, and São Paulo city is an important center for that; ii. historical records of *H. flammeus* in museum collections of specimens from the rio Tietê drainages, a historically well-sampled region, are very recent, scarce and punctual around São Paulo city metropolitan area, and absent for example, from the Serra de Paranapiacaba (rio Pinheiro drainage) in pristine areas; iii. relative abundance of *H. flammeus* in recent samplings are restricted to streams with some traces of degradation and near São Paulo city metropolitan area; iv. sharing species among adjacent drainages are more commonly restricted to headwaters of adjacent areas, in relatively pristine rivers/streams; v. there is a relatively large gap between Rio de Janeiro drainages and the rio Tietê drainages without occurrence of *H. flammeus*, a relatively well-sampled area. However, in order to test this hypothesis, a molecular analysis would provide more data about differences (or not) and time of separation between the two populations.

The first record of *H. flammeus* in a Brazilian collection dates from 1954 (MNRJ 8795, Rio de Janeiro, Guanabara bay basin). After this record, few lots and individuals were added, mainly in MNRJ, evidencing that populations of *H. flammeus* in its natural area is very rare. The last record from Rio de Janeiro State is of 1972. Most records, however, date from early 21st century for São Paulo State. This paradox of few records in scientific collections of a relatively common species in the aquarium trade is also found in some other species, such as *Hemigrammus erythrozonus* Durbin, *Hyphessobrycon roseus* (Géry), *H. takasei* Géry, *Inpaichthys kerri* Géry & Junk, *Tucanoichthys tucano* Géry & Römer, to mention some. Surprisingly, on the other hand, these species are frequently found, particularly *H. flammeus*, in aquarium stores in Brazil and foreign countries. Many of this species are bred and kept in aquarium.

Due to its bright color and its easy maintenance in aquarium, *H. flammeus* is very appreciated by aquarists, exported to several countries in Europe and the United States. Commercialization of species, associated with pollution, urbanization, agricultural and industrial activities, damming of lotic courses, substitution of marginal and riparian vegetation, introduction of species (*e.g.*, tilapia and black-bass), are the main deleterious anthropic effects which threaten its natural occurrence and abundance in pristine environments.

Therefore, conservation actions for *H. flammeus* should mainly prioritize the protection of its natural habitats, or allochthonous, and a more strict control of aquarium trade. The occurrence of threatened species in the most populous and industrial area of Brazil (Rio de Janeiro and São Paulo cities) requires additional efforts for the maintenance and perpetuation of these taxa in the Neotropical region.

Comparative material examined. *Hyphessobrycon condotensis*, BMNH 1913.10.1.19-21, syntypes, 4, 14.4-33.1 mm SL, Colombia, río Condoto, southwest Colombia.

Acknowledgments

We are grateful to Jaqueline Zeni (UNESP) by helping with analysis of stomach contents; Vinicius A. Bertaco (MCN, FZB-RS) for valuable comments and criticisms; to curators by permitting access to collections under their care: James Maclaine and Tracy Heath (BMNH); Claudio Oliveira (LBP), Sonia Fisch-Muller and Raphael Covain (MHNG); Osvaldo Oyakawa and Naércio A. Menezes (MZUSP), Paulo A. Buckup and Marcelo R. Britto (MNRJ). The senior author is financed by a postdoctoral fellowship from FAPESP (proc. 2011/1144-8 and 2012/03404-6); GCJ by a scientific initiation fellowship from FAPESP (proc. 2012/06846-6). SEM preparations were made in MZUSP, with the help of Manoela M. F. Marinho (MZUSP), supported by FAPESP (proc. 2011/50282-7). Sandra Raredon (NMNH) made the photo of syntype; color images were provided by Peter and Martin Hoffmann.

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Submitted October 31, 2013

Accepted February 7, 2014 by Luiz R. Malabarba

Published June 30, 2014