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Simpsonichthys harmonicus, a new seasonal killifish from the São Francisco River basin, northeastern Brazil (Cyprinodontiformes: Rivulidae)

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Simpsonichthys harmonicus, new species, is described from the left floodplains of the middle São Francisco River, northeastern Brazil. It is considered to be closely related to *S. magnificus* and *S. picturatus*, also endemic to the middle São Francisco River basin, by all possessing a combination of apomorphic states of morphological characters in males, including red pectoral fin, narrow black stripe on the distal margin of the unpaired fins and the ventral margin of the pectoral fin, dorsal and anal fin extremity approximately rounded, without filamentous rays. The new species is distinguished from *S. magnificus* and *S. picturatus* by the combination of pectoral fin reaching a vertical between bases of the fourth and fifth anal-fin rays in males; 21-22 caudal-fin rays; caudal fin length 31.2-33.2 % SL in males; pre-pelvic length 44.2-47.6 % SL in males; 5-7 transverse rows of dots on dorsal fin, 6-8 on anal fin, and 6-8 on caudal fin; blue stripes on the distal portion of the dorsal fin in males; and, 13-16 bars on the flank in females.

Simpsonichthys harmonicus sp. n., é descrita da várzea esquerda do médio rio São Francisco, nordeste do Brasil. Ela é considerada ser estreitamente relacionada a *S. magnificus S. picturatus*, também endêmicas da bacia do médio Rio São Francisco, por todas possuírem uma combinação de estados apomórficos de caracteres morfológicos em machos, incluindo nadadeira peitoral vermelha, estreita faixa negra na margem distal de nadadeiras ímpares e na margem ventral da nadadeira peitoral, extremidade de nadadeiras dorsal e anal aproximadamente arredondadas, sem raios filamentosos. A nova espécie se distingue de *S. magnificus* e *S. picturatus* pela combinação de nadadeira peitoral atingindo uma vertical entre as bases do quarto e quinto raios da nadadeira anal em machos; 21-22 raios na nadadeira caudal; comprimento da nadadeira caudal 31,2-33,2 % do comprimento padrão em machos; comprimento pré-pélvico 44,2-47,6 % do comprimento padrão em machos; 5-7 fileiras transversais de pontos azuis na nadadeira dorsal, 6-8 na nadadeira anal, e 6-8 na nadadeira caudal; faixas azuis na porção distal da nadadeira dorsal em machos; e, 13-16 barras no flanco em fêmeas.

Introduction

No species of the Rivulidae was known to occur in the São Francisco River basin, the third largest river basin of South America, until 1989. The first record of a seasonal rivulid killifish for that basin was made by Costa & Brasil (1990), starting a series of expeditions to sample annual fish habitats. In this region, annual fish habitat comprises shallow, isolated seasonal pools formed during

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the rain season (November-April). During the subsequent 20 years, a great species diversity of seasonal killifishes was detected, with 33 valid species recognized in the most recent revisions (Costa, 2001, 2007).

Among the species of *Simpsonichthys* endemic to the São Francisco River basin, a clade comprising *S. magnificus*, *S. picturatus* and *S. carlettoi* is diagnosed by a red pectoral fin in males (Costa, 2006). This clade is endemic to the middle section of the basin: *S. magnificus* is known from localities along the floodplains of the São Francisco River between Manga in Minas Gerais State and Malhada in southern Bahia State, and the floodplains of the lower Verde Grande River, a right tributary to the São Francisco River in Minas Gerais State; *S. picturatus* is endemic to the floodplains of the São Francisco River between Paratinga and Barra, both in Bahia State; and, *S. carlettoi* is known from a small area of the middle das Rãs River basin, a right tributary of São Francisco River in Bahia State (Costa, 2007). A fourth species of this clade, from Bom Jesus da Lapa, Bahia, is herein described.

Material and methods

Morphological characters were obtained from specimens fixed in formalin just after collection, for a period of 10 days, and then transferred to ethanol 70 %. Exceptions were specimens kept alive for one or two days, which were photographed in life. Material is deposited in the Ichthyological collection of the Instituto de Biologia, Universidade Federal do Rio de Janeiro, Rio de Janeiro (UFRJ). Descriptions of color patterns were based both on direct examination of live specimens in the field just after collection, in small recipients with translucent walls, and photographs of both sides of some live individuals (usually three males and two females) taken in aquaria one day after collection, then fixed as described above. Measurements and counts follow Costa (1995). Measurements are presented as percent of standard length (SL), except for those related to head morphology, which are expressed as percent of head length. Fin-ray counts include all elements. Number of vertebrae and gill-rakers were recorded from cleared and stained specimens; the compound caudal centrum was counted as a single element. Osteological preparations were made according to Taylor & Van Dyke (1985). Terminology for bones follows Costa (2006), for frontal squamation Hoedeman (1958) and for cephalic neuromast series Costa (2001). Delimitation of species follows the methodology of the Population Aggregation Analysis (Davis & Nixon, 1992), in which species are delimited by a unique combination of stable morphological character states in one or more populations.

Simpsonichthys harmonicus, new species
(Figs. 1-2)

Holotype. UFRJ 6696, male, 29.4 mm SL; Brazil: Estado da Bahia: Município de Bom Jesus da Lapa: seasonal pool close to the road BR-349, ca. 12 km of the left bank of São Francisco River, 13°15'42" S 43°31'28" W, altitude 437 m; W. J. E. M. Costa, M. A. Barbosa, L. Alexandre & A. Oliveira, 8 May 2009.

Paratypes. UFRJ 6697, 4 males, 26.8-31.3 mm SL, 10 females, 24.6-26.6 mm SL; UFRJ 6698, 1 male, 30.2 mm SL, 3 females, 26.2-26.3 mm SL (c&s); collected with holotype.

Diagnosis. Similar to *S. carlettoi*, *S. magnificus* and *S. picturatus* and distinguished from the remaining congeners by having a combination of red pectoral fin in males (vs. hyaline) and three red bars alternating with three or four dark greenish gray bars on anterior portion of the flank in males (vs. never a similar color pattern). Distinguished from those three species by having shorter dorsal and anal fins in males, their extremities reaching a vertical anterior to caudal-fin base (vs. reaching between caudal-fin base and middle of caudal fin). Also distinguished from *S. carlettoi* by having the extremity of the dorsal and anal fins rounded (vs. pointed), distal margin of unpaired fins and ventral margin of pectoral fin black in males (vs. without black pigment), greater pre-pelvic length (44.2-47.6 % SL in males, 52.6-54.5 % SL in females, vs. 41.8-43.3 % SL and 50.9-51.0 % SL, respectively) and shorter caudal fin in males (31.2-33.2 % SL, vs. 37.6-39.0 % SL); from *S. magnificus* by having shorter pectoral fin in males, its extremity reaching a vertical between bases of the fourth and fifth anal-fin rays (vs. between bases of sixth and eighth anal-fin rays), fewer caudal-fin rays (21-22 vs. 23-25), and shorter caudal fin in males (31.2-33.2 % SL, vs. 34.9-39.3 % SL); and, from *S. picturatus* by having

greater pre-pelvic length in males (44.2-47.6 % SL vs. 39.9-43.0 % SL), fewer transverse rows of blue dots on unpaired fins in males (5-7 on dorsal, 6-8 on anal, and 6-8 on caudal, vs. 8-12, 10-12, and 10-12, respectively), blue stripes on the distal portion of the dorsal fin in males (vs. without blue stripes) and fewer bars on the flank in females (13-16 vs. 17-20).

Description. Morphometric data appear in Table 1. Largest male examined 31.3 mm SL; largest female examined 26.6 mm SL. Dorsal and ventral profiles convex between snout and anterior part of caudal peduncle, nearly straight on caudal peduncle. Body moderately deep, compressed, greatest body depth at level of pelvic-fin base. Eye positioned on dorsolateral portion of head side. Snout short, blunt.

Unpaired fins rounded in both sexes, without filaments. Pectoral fin long, slightly pointed, tip reaching vertical between base of 4th and 5th anal-fin rays in males, reaching between anus and urogenital papilla in females. Tip of pelvic fin reaching base of 2nd anal-fin ray in males and reaching urogenital papilla in females. Pelvic-fin bases medially in close proximity. Dorsal-fin origin anterior to anal-fin origin in males, through vertical between pelvic-fin base and anus, anal-fin origin through vertical between base of second or third dorsal-fin ray; dorsal-fin origin posterior to anal-fin origin in females, between base of second and fourth anal-fin rays. Dorsal-fin origin between neural spines of vertebrae 7 and 8 in males, and neural spines of vertebrae 10 and 12 in females. Anal-fin origin between pleural ribs of vertebrae 7 and 8 in males, and pleural ribs of vertebrae 8 and 10 in females. Dorsal-fin rays 22-24 in males, 14-16 in females; anal-fin rays 19-21 in males, 17-19 in females; caudal-fin rays 21-22; pectoral-fin rays 12-13; pelvic-fin rays 5.

Frontal squamation E-patterned; E-scales overlapping medially; no row of scales anterior to H-scale; one small supraorbital scale. Longitudinal series of scales 26-27; transverse series of scales 10; scale rows around caudal peduncle 12. Contact organ on each scale of ventral portion of flank. Minute papillate contact organs on inner surface of first three pectoral fin-rays in males. No contact organs on pelvic and unpaired fins.

Cephalic neuromasts: supraorbital 13-15, parietal 2, anterior rostral 1, posterior rostral 1, infraorbital 2+19-21, preorbital 3-4, otic 1-2, postotic 1, supratemporal 1, median opercular 1, ventral opercular 1, preopercular 14-15, mandibular 8-10, lateral mandibular 5-6, paramandibular 1. One neuromast on each scale of lateral line. Two neuromasts on caudal-fin base.

Basihyal subtriangular, width about 45 % of

Table 1. Morphometric data of *Simpsonichthys harmonicus*. Values for holotype included in range of values of males.

	holotype UFRJ 6696	males (n=5)	females (n=7)
Standard length (mm)	29.4	26.8-31.3	24.6-26.2
Percent of standard length			
Body depth	35.9	35.0-38.6	35.4-38.2
Caudal peduncle depth	15.6	14.7-17.2	14.3-15.9
Predorsal length	45.9	44.0-46.6	61.7-63.9
Prepelvic length	46.8	44.2-47.6	52.6-54.5
Length of dorsal-fin base	43.0	40.3-45.5	20.0-26.2
Length of anal-fin base	39.1	39.1-41.5	22.0-24.2
Caudal-fin length	33.2	31.2-33.2	33.4-35.3
Pectoral-fin length	28.0	26.0-28.0	24.3-26.7
Pelvic-fin length	9.6	9.3-10.6	10.6-12.3
Head length	27.5	27.5-28.9	29.8-32.1
Percent of head length			
Head depth	107.5	100.7-111.5	95.2-102.2
Head width	68.3	67.6-70.8	70.0-77.1
Snout length	16.7	14.4-16.7	13.1-14.8
Lower jaw length	19.8	17.9-21.9	14.3-16.0
Eye diameter	33.7	31.9-35.6	32.2-35.6

Fig. 1. *Simpsonichthys harmonicus*, UFRJ 6696, holotype, male, 29.4 mm SL; Brazil: Bahia: Bom Jesus da Lapa.

Fig. 2. *Simpsonichthys harmonicus*, UFRJ 6697, paratype, female, 26.6 mm SL; Brazil: Bahia: Bom Jesus da Lapa.

length; basihyal cartilage about 25 % of total length of basihyal. Six branchiostegal rays. One or two teeth on second pharyngobranchial. Gill-rakers on first branchial arch 3 + 9. Vomerine teeth absent. Dermosphenotic absent. Ventral process of posttemporal well developed. Total vertebrae 26-27.

Coloration. Males. Side of body light pink, with red bars, more conspicuous on anterior portion of flank, three anteriormost red bars alternating with three or four dark greenish gray bars; vertically elongated, minute metallic blue spots, one per scale, on whole flank. Venter light yellow ochre. Head side yellow ochre, pale golden with small blue spots on opercular region; margin of scales of dorsoposterior region of head red. Iris

light yellow with dark reddish brown bar through center of eye. Unpaired fins dark red with transverse rows of greenish blue dots; dots of distal portion of dorsal fin fused, forming stripes perpendicular to fin rays, often similar stripes on distal portion of caudal fin, sometimes on posterior portion of anal fin; distal margin of unpaired fins black. Pectoral fin red, ventral margin black. Pelvic fin dark red with black and blue dots on tip.

Females. Side of body light purplish gray, with 13-16 faint dark greenish gray interrupted bars, more conspicuous in preserved specimens; venter pale orangish gray; one to three rounded black blotches on central portion of body side excluding caudal peduncle. Opercular region pale golden. Iris light yellow with gray bar through center of eye. Fins hyaline; small light blue spot on posterior margin of anal fin, just posterior to fin base.

Distribution and habitat. *Simpsonichthys harmonicus* is known only from the type locality, a seasonal pool in the floodplains of the São Francisco River, about 12 km of the left river bank, close to the road BR-349, Bom Jesus da Lapa, Bahia, northeastern Brazil. The pool was surrounded by a typical vegetation of the Brazilian Caatinga semi-arid region. The pool was shallow, about 0.50 m deep, water slightly turbid, brownish yellow. *Simpsonichthys harmonicus* was collected only in places with dense aquatic vegetation, contrasting to the other three seasonal killifish species found in the same pool, *Simpsonichthys flagellatus*, *Cynolebias gilbertoi* and *C. attenuatus*, which were mainly found in areas more exposed to the sunlight.

Etymology. From the Latin *harmonicus* (harmonious), referring to the color pattern of males. An adjective.

Discussion

Simpsonichthys harmonicus belongs to the clade diagnosed by the presence of a red pectoral fin in males (Costa, 2006), which also includes *S. carlettoi*, *S. picturatus* and *S. magnificus*. Among them, *S. harmonicus* share with *S. picturatus* and *S. magnificus* the presence of a black stripe on the distal margin of the unpaired fins and the ventral margin of the pectoral fin in males (Costa, 2006, 2007), a condition not occurring in *S. carlettoi*, in which black pigment is absent on the fin margins. *Simpsonichthys harmonicus* is also similar to *S. picturatus* and *S. magnificus*, by dorsal and anal fins without short filamentous rays, which are present in males of *S. carlettoi* and considered a primitive condition for cynolebiasine killifishes (Costa, 2006). However, the dorsal and the anal fin morphology of *S. harmonicus* slightly differs from that in *S. picturatus* and *S. magnificus* by being always rounded and shorter, its extremity never posteriorly reaching caudal-fin base. In *S. picturatus* and *S. magnificus*, the extremity of the dorsal and anal fins is rounded or may be slightly pointed, and longer, reaching the caudal-fin base.

The color pattern of the unpaired fins in males, used to distinguish *S. picturatus* and *S. magnificus* (e. g., Costa, 2007), may present some intra-specific variability. In *S. picturatus*, there are transverse rows of blue dots, a condition considered as plesiomorphic for cynolebiasines (Costa, 2006), while in *S. magnificus*, most dots are fused to form transverse vermiculate-shaped stripes, considered as an autapomorphic condition (Costa, 2006). However, in *S. picturatus* vermiculate marks may be present on the distal portion of the caudal fin and posterior portion of the anal fin, and in *S. magnificus*, dots (not fused) may be present on the basal portion of the dorsal and caudal fins, and posterior portion of the anal fin. The presence of transverse blue stripes on the distal portion of the dorsal fin distinguishes *S. harmonicus* from *S. picturatus*, as well as the number of transverse rows of dots or vermiculate marks, distinctively lower in *S. harmonicus* (5-7 on dorsal, 6-8 on anal, and 6-8 on caudal, vs. 8-12, 10-12, and 10-12, respectively). *Simpsonichthys harmonicus* is also distinguished from *S. picturatus* by having greater pre-pelvic length in males (44.2-47.6 % SL vs. 39.9-43.0 % SL) and fewer bars on the flank in females (13-16 vs. 17-20), and from *S. magnificus* in having shorter pectoral fin in males, its extremity reaching the vertical between bases of the fourth and fifth anal-fin rays (vs. between bases of sixth and eighth anal-fin rays), fewer caudal-fin rays (21-22 vs. 23-25), and shorter caudal fin in males (31.2-33.2 % SL, vs. 34.9-39.3 % SL).

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