



Simpsonichthys margaritatus, a new seasonal miniature killifish from the upper Paraná River basin, central Brazilian Cerrado (Cyprinodontiformes: Rivulidae)

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Simpsonichthys margaritatus, new species, is described from the Verde River floodplains, upper Paraná River basin, central Brazil. It is distinguished from all other congeners by having series of small light blue to light yellow spots arranged in close proximity on the dorsal and caudal fins in males and oblique dark brown bars on the anal fin in females. It is member of a clade including miniature species endemic to an area of central Brazilian high plateaus drained by rivers connected to the lower section of the Paranaíba River and adjacent upper tributaries of the Araguaia River. The new species seems to be more closely related to *S. cholopteryx*, from the upper Araguaia River basin, by both having oblique red bars on the anal fin in males.

Simpsonichthys margaritatus, sp. nov., da várzea do rio Verde, bacia do alto rio Paraná, Brasil central, é descrita. Ela se distingue de todos os congêneres por possuir séries de pequenas máculas azul claras a amarelo claras dispostas em estreita proximidade nas nadadeiras dorsal e caudal em machos e barras oblíquas castanho escuras na nadadeira anal em fêmeas. Ela é um membro de um clado que inclui espécies miniaturas endêmico de uma área do planalto central brasileiro drenada por rios conectados à seção inferior do rio Paranaíba e tributários superiores do rio Araguaia adjacentes. A nova espécie parece ser mais proximamente aparentada a *S. cholopteryx*, da bacia do alto rio Araguaia, por ambas possuírem barras oblíquas vermelhas na nadadeira anal em machos.

Introduction

Simpsonichthys was first described as a monotypic genus to include *S. boitonei* Carvalho, a species endemic to the uplands of central Brazil (Carvalho, 1959; Costa & Brasil, 2006). Parenti (1981) considered the genera *Simpsonichthys*, *Campellolebias* and *Terranatos* as synonyms of *Cynolebias*. However, subsequent phylogenetic

analyses of rivulids (Costa, 1990, 1998; Hrbek & Larson, 1999; Murphy et al., 1999) have supported *Cynolebias* sensu Parenti (1981) as a polyphyletic assemblage. Costa (1996, 2006, 2007a) considered *Simpsonichthys* as a valid genus, including over 50 nominal species, many of which previously placed in *Cynolebias*, restricting the latter genus to a clade endemic to northeastern Brazil (see also Costa, 2001, for a taxonomic revi-

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sion of *Cynolebias*). However, after a more comprehensive analysis (Costa, 2010), *Simpsonichthys* sensu Costa (1996, 2007a) was considered as a paraphyletic group. Consequently, *Simpsonichthys* was restricted to a clade of small seasonal killifishes endemic to the uplands of central Brazil (e.g., Costa, 2010), equivalent to the subgenus *Simpsonichthys* sensu Costa (2007a).

The seven species presently included in *Simpsonichthys* (*S. boitonei*, *S. cholopteryx*, *S. nigromaculatus*, *S. parallelus*, *S. punctulatus*, *S. santanae*, *S. zonatus*) are found in shallow seasonal savannah swamps connected to the upper sections of the Araguaia, Paraná and São Francisco river basins (Costa, 2007a, 2010). An eighth species of the genus, collected in the Paranaíba River drainage of the upper Paraná River basin, is herein described.

Material and methods

Specimens were fixed in formalin for a period of 10 days, and then transferred to 70 % ethanol. Material is deposited in the ichthyological collection of the Instituto de Biologia, Universidade Federal do Rio de Janeiro, Rio de Janeiro (UFRJ). Descriptions of colour patterns were based on direct examination of live specimens in the field just after collection, and photographs of both sides of live individuals taken one day after collection; all specimens of the type series were fixed in formalin immediately after photographs were taken. 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 frontal squamation follows Hoedeman (1958) and for cephalic neuromast series Costa (2001). Delimitation of species is according to the methodology of the Population Aggregation Analysis (Davis & Nixon, 1992), in which species are delimited by a unique combination of morphological character states.

Simpsonichthys margaritatus, new species (Figs. 1–2)

Holotype. UFRJ 8339, male, 27.2 mm SL; Brazil: Estado de Goiás: Município de Serranópolis: floodplains of Verde River, a tributary of Paranaíba River, upper Paranaíba River basin, near road GO-184, 18°22'29" S 52°00'59" W, altitude 527 m; W. J. E. M. Costa et al., 17 Sep. 2011.

Paratypes. UFRJ 8340, 1 female, 19.4 mm SL; UFRJ 8341, 1 male, 23.9 mm SL, 1 female, 18.2 mm SL (c&s); collected with holotype.

Diagnosis. *Simpsonichthys margaritatus* is distinguished from all other species of the genus by the presence of small light blue spots in close proximity to form vertical series on the dorsal and anal fins in males (vs. absence of light spots or dots in *S. cholopteryx*, *S. nigromaculatus* and *S. parallelus*, and presence of isolated light blue dots not forming vertical series in *S. boitonei*, *S. punctulatus*, *S. santanae* and *S. zonatus*) and dark brown bars on the basal portion of anal fin in females (vs. bars absent). *Simpsonichthys margaritatus* is similar to *S. cholopteryx*, *S. nigromaculatus* and *S. parallelus* by having a dark grey band bordered by a bright blue line on the distal margin of the dorsal and anal fins in males, anterior and posterior margins of iris bright blue, anterior two supraorbital neuromasts separated from posterior supraorbital neuromasts by interspace, and fewer (4–6) mandibular neuromasts (vs. never a similar colour pattern of dorsal and anal fins in males, iris entirely yellow, supraorbital neuromasts arranged continuously, and 8–12 mandibular neuromasts in *S. boitonei*, *S. punctulatus*, *S. santanae* and *S. zonatus*). The new species is easily distinguished from *S. cholopteryx*, *S. nigromaculatus* and *S. parallelus* by having small blue or yellow spots on the dorsal and caudal fins in males (vs. spots absent). *Simpsonichthys margaritatus* is similar to *S. cholopteryx* by both, uniquely in the genus, having oblique bars on the anal fin in males (vs. bars absent); besides the characters listed above, *S. margaritatus* is also distinguished from *S. cholopteryx* by possessing bright blue bars on flank in males much narrower than interspaces (vs. approximately as wide as red bars), by the absence of bars on the dorsal and caudal fins in males (vs. presence), fewer rows of scales around caudal peduncle (12 vs. 14–16), and more preopercular neuromasts (10–11 vs. 7).



Description. Morphometric data appear in Table 1. Largest male examined 27.2 mm SL; largest female examined 19.4 mm SL. Dorsal profile convex from snout to end of dorsal-fin base, approximately straight on caudal peduncle. Ventral profile gently convex from lower jaw to end of anal-fin base, about straight on caudal peduncle. Body moderately deep, compressed. Greatest body depth at vertical just in front to anal-fin origin. Jaws short, snout blunt.

Extremity of dorsal and anal fins slightly pointed. Caudal fin oval. Pectoral fin elliptical, posterior margin in vertical through base of 4th anal-fin ray in males, in vertical through anus in females. Pelvic fin and girdle absent. Dorsal-fin origin on vertical through base of 5th anal-fin ray in males, through base of 2nd anal-fin ray in females; second proximal radial of dorsal fin between neural spines of 10th and 11th vertebrae in males, between neural spines of 11th and 12th vertebrae in females; first proximal radial of anal fin between pleural ribs of 7th and 8th vertebrae in males, between pleural ribs of 9th and 10th vertebrae in females. Dorsal-fin rays 18–19 in males, 14–17 in females; anal-fin rays 23 in males, 19–20 in females; caudal-fin rays 25; pectoral-fin rays 13.

Scales small, cycloid. Body and head entirely scaled, except anterior ventral surface of head. Body squamation extending over anterior 30 % of caudal-fin base; no scales on dorsal and anal-fin bases. Frontal squamation E-patterned; E-scales overlapping medially; scales arranged in transverse pattern; G-scale just posterior to snout. Two supraorbital scales. Longitudinal series of scales 25; transverse series of scales 9; scale rows around caudal peduncle 12. One contact organ on margin of each scale of ventral part of flank and caudal peduncle in males. Minute contact organs on first uppermost pectoral-fin ray in males.

Cephalic neuromasts: supraorbital 2 + 6, parietal 2, anterior rostral 1, posterior rostral 1, infra-orbital 2 + 12–13, preorbital 2, otic 1, post-otic 1, supratemporal 1, median opercular 1, ventral opercular 1, preopercular 10–11, mandibular 5–6, lateral mandibular 2–3, paramandibular 1. Lateral line interrupted, alternating scales with and without neuromasts. Two neuromasts on caudal-fin base.

Basihyal subtriangular, greatest width about 40 % of length; basihyal cartilage about 20 % of total length of basihyal. Six branchiostegal rays. Second pharyngobranchial teeth absent. Gill-

rakers on first branchial arch 1 + 8. Vomerine teeth absent. Dermosphenotic absent. Ventral process of posttemporal absent. Total vertebrae 26.

Coloration. Males. Middle and ventral portions of flank and venter with 12 broad red crimson bars alternating with narrow light blue bars, red bars about four or five times wider than blue bars; dorsal portion of flank dark red crimson with longitudinal rows of small greenish golden spots. Dorsum light yellowish brown. Side of head metallic blue, with four red crimson vertical bars between posterior margin of orbit and posterior margin of opercle, one similar bar below eye, and short oblique red crimson bar between orbit and lower jaw. Lower jaw pink. Anterior and posterior portion of iris metallic blue; bar through centre of eye, dark orange above and dark reddish brown below pupil. Dorsal fin red with light blue small spots arranged in close proximity, often forming oblique series; distal margin reddish grey with narrow light blue border. Anal fin bluish white with oblique red continuing those of flank bars; distal margin dark grey with narrow light blue border. Caudal fin with light blue spots arranged in close proximity, light blue dorsal and posterior portions of fin, yellow on centre and anteroventral portion; spots, often forming vertical series. Pectoral fin hyaline.

Females. Side of head and flank light yellowish or pinkish brown, with 12 dark grey bars; one

Table 1. Morphometric data of *Simpsonichthys margaritatus*. H, holotype.

	H	paratypes		
	♂	♂	♀	♀
Standard length (mm)	27.2	23.9	19.4	18.2
Percent of standard length				
Body depth	33.2	31.1	27.7	28.1
Caudal peduncle depth	15.5	14.3	14.3	14.4
Predorsal length	55.8	53.8	64.0	65.6
Length of dorsal-fin base	32.5	32.7	28.5	23.6
Length of anal-fin base	40.4	37.9	29.2	26.7
Caudal-fin length	35.5	34.0	37.7	–
Pectoral-fin length	22.2	21.0	22.9	23.7
Head length	29.1	29.4	31.3	32.7
Percent of head length				
Head depth	98.6	88.1	82.0	81.3
Head width	67.8	66.6	68.1	66.1
Snout length	14.0	12.7	12.9	12.8
Lower jaw length	19.0	16.7	16.0	14.6
Eye diameter	34.9	35.6	35.9	36.5



Fig. 1. *Simpsonichthys margaritatus*, UFRJ 8339, holotype, male, 27.2 mm SL; Brazil: Goiás: Serranópolis.



Fig. 2. *Simpsonichthys margaritatus*, UFRJ 8340, paratype, female, 19.4 mm SL; Brazil: Goiás: Serranópolis.

rounded grey blotch on anterocentral portion of flank. Iris yellow, anterior and posterior borders bright blue, with dark brown bar through centre of eye. Dorsal fin hyaline with dark brown spots on basal portion and transverse series of brown dots on remaining portion of fin. Anal fin light grey with dark brown bars on basal three quarters of fin, pinkish hyaline without dark marks on distal portion. Caudal fin hyaline to yellow on centre and pink on posterior portion, with minute dark brown spots. Pectoral fin hyaline.

Distribution and habitat. All specimens of the type series were collected in temporary pools in the floodplains of the Verde River, a tributary of the Paranaíba River, upper Paraná River basin, central Brazil. The only other species found in this habitat was *Melanorivulus rutilicaudus*. The pools were about 0.3 m deep, the water was clear,

amber yellow coloured. The Verde River at the type locality region is bordered by broad floodplains, extending about 500 m in width from each river margin. Both the river channel and its floodplains, in altitudes of about 520–530 m, are in a deep valley surrounded by higher plateaus, with altitudes about 700–750 m. The greatest part of the river floodplains was dry at the time of the collection, except some seasonal pools within the gallery forest close to the river channel. The type locality region is situated within the savannah-like Cerrado vegetation of central Brazil.

Etymology. From the Latin *margaritatus* (ornate with pearls), referring to the colour pattern of dorsal and caudal fin in males, in which there are small light spots arranged in close proximity, remembering pearl collars. An adjective.



Discussion

Species of the genus *Simpsonichthys* belong to two clades occurring in geographically separate areas, one in the plateaus between the Paraná and São Francisco river basins (the eastern clade) and the other in the plateaus between the Paraná and Araguaia river basins (the western clade) (Costa, 2006, 2007b, 2010). The eastern clade comprises *S. boitonei* and *S. santanae* from the upper São Bartolomeu River drainage, which is a part of the upper Paranaíba River drainage, upper Paraná River basin (Costa & Brasil, 2006; Costa, 2007a) and *S. punctulatus* and *S. zonatus* from the upper sections of the Urucuia and Paracatu river drainages of the São Francisco basin (Costa & Brasil, 1990, 2007); the western clade includes *S. parallelus* and *S. nigromaculatus* from the western tributaries of the lower Paranaíba River drainage, upper Paraná River basin and *S. choloptyyx* from the upper section of the Araguaia River basin (Costa, 2007a). Both geographical distribution and morphology are congruent with the placement of *S. margaritatus* as a member the western clade – its type locality is situated in the Verde River floodplains, a western tributary of the lower Paranaíba River drainage, and it exhibits all derived character states of that group: presence of a dark grey band bordered by a bright blue line on the distal margin of the dorsal and anal fins in males, anterior and posterior margins of iris bright blue, anterior two supraorbital neuromasts separated from posterior supraorbital neuromasts by interspace, and fewer (4–6) mandibular neuromasts. In addition, all species of the western clade, including *S. margaritatus*, are miniature species, with maximum adult size between about 23 and 27 mm SL (vs. between about 30 and 36 mm SL in other congeners). Among species of the western clade, *S. margaritatus* seems to be more closely related to *S. choloptyyx* by both species having oblique bars on the anal fin in males, a colour pattern not found elsewhere among congeners.

Simpsonichthys margaritatus was unexpectedly collected during the peak of the dry season of the region (September), although only four specimens were found after some hours of intensive efforts to sample the habitat by six persons. In this part of Brazil, the single annual rainy season is concentrated between October and April. In a first visit to the region (15 January 2004), when only the non-seasonal rivulid *Melanorivulus rutilicaudus* was found (Costa, 2005), the entire marginal area

of the Verde River was flooded, leaving no isolated temporary pools, the typical annual killifish habitat (shallow seasonal pools). However, only a continued field study in the future along the whole annual cycle will provide accurate data about the unusual occurrence of adult seasonal killifishes during the peak of the dry period.

Acknowledgements

I am grateful to F. Estrella, M. A. Barbosa, F. Ottoni, O. Simões, G. Silva, and J. Oliveira for technical assistance in the field. Thanks are due to M. Kottelat and two anonymous reviewers for providing useful suggestions and corrections. This study was supported by CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico – Ministério de Ciência e Tecnologia).

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Received 5 October 2011
 Revised 14 December 2011
 Accepted 3 January 2012