

## *Rivulus cearensis*, a new aplocheiloid killifish from northeastern Brazil (Cyprinodontiformes: Rivulidae)

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*Rivulus cearensis*, new species, from São Gonçalo do Amarante, Ceará, northeastern Brazil, is described. It was found in a shallow stream within a residual humid forest inserted in the semi-arid Caatinga region. The new species seems to be closely related to *R. bahianus* and to the species of the *R. urophthalmus* group by all having the ventral surface of head entirely covered by scales and flank with horizontal rows of small reddish brown or red spots in males; it differs from all those species by possessing iris green and by the absence of the ventral process of the posttemporal bone. It is also distinguished from *R. bahianus* by having more robust body and a broad dark red stripe on the dorsal and ventral margins of the caudal fin in males, and from species of the *R. urophthalmus* group by having fewer scales in the longitudinal series and scales extending over about 40-50 % of the caudal fin.

*Rivulus cearensis*, sp. n., de São Gonçalo do Amarante, Ceará, nordeste do Brasil, é descrita. Ela foi encontrada em um riacho raso dentro de uma mata úmida residual inserida na região semi-árida da Caatinga. A nova espécie parece estar estreitamente relacionada a *R. bahianus* e a espécies do grupo *R. urophthalmus* por todas possuírem a superfície ventral da cabeça totalmente coberta por escamas e flanco com fileiras horizontais de pequenas manchas castanho avermelhadas ou vermelhas em machos; ela difere de todas aquelas espécies por possuir íris verde e pela ausência do processo ventral do osso pós-temporal. Ela também se distingue de *R. bahianus* por possuir corpo mais robusto e uma faixa vermelho escura nas margens dorsal e ventral da nadadeira caudal em machos, e de espécies do grupo *R. urophthalmus* por possuir menos escamas na série longitudinal e escamas se estendendo sobre cerca de 40-50 % da nadadeira caudal.

### Introduction

The first record of a species of the killifish genus *Rivulus* for northeastern Brazil was made by Henn (1916), when he reported eight specimens collected by Haseman in Rio Catu, an isolated

coastal river drainage of northeastern Bahia state. Henn (1916) identified those specimens as *R. urophthalmus*, a species endemic to the eastern Amazon Forest (Costa, 2006). That species from northeastern Brazil was later recognized as new and described by Huber (1990) as *Rivulus bahianus*,

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based on material from an Atlantic Forest area near the city of Salvador, northeastern Bahia state. *Rivulus bahianus* was considered by Huber (1992) as closely related to other species of *Rivulus* endemic to the Atlantic Forest region of Brazil (i.e., the *R. santensis* group = *Atlantirivulus*), although *R. bahianus* does not share any derived morphological feature with these species (Costa, 2008a). However, Huber (1992) considered *R. bahianus* as a link between the *R. santensis* group and the *R. urophthalmus* group, an assemblage endemic to the Amazon Forest. *Rivulus bahianus* differs from species of the *R. urophthalmus* group by having fewer scales in the longitudinal series (34-35 vs. 37-50) and scales extending over 40-50 % of the caudal fin (vs. 25-30 %) (Huber, 1992; Costa, 2008a).

Costa (2008a) redescribed *R. bahianus* and noted that besides sharing derived color patterns with species of the *R. urophthalmus* group (subgenus *Cynodonichthys*, including *R. cryptocallus*, *R. deltaphilus*, *R. elongatus*, *R. hartii*, *R. igneus*, *R. lungi*, *R. micropus*, *R. rubrolineatus*, *R. stagnatus*, *R. taeniatus*, and *R. urophthalmus*), it also shares with them a unique head squamation pattern, in which the scales of the ventral surface of the head reach forward to the chin, while in all other rivulids the chin is not scaled. Costa (2008a) concluded that *R. bahianus* is closely related to that geographically distant assemblage of *Rivulus*, all endemic to the Amazon Forest region and adjacent parts of northern South America and Caribbean islands, instead of related to other species endemic to the Atlantic Forest, which compose the subgenus *Atlantirivulus* (Costa, 2008b). The most-eastern record for the *R. urophthalmus* group is represented by the occurrence of *R. urophthalmus* in the Maranhão state of northeastern Brazil (Costa, 2006), in localities separated about 1200 km from the nearest known locality of *R. bahianus*. This broad geographic gap is herein narrowed by the description of *R. cearensis* from an isolated coastal basin of the Ceará state, about midway between the geographic ranges of the *R. urophthalmus* group and *R. bahianus*.

#### Material and methods

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, gill-rakers, and caudal-fin rays were recorded only 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). Material is deposited in UFRJ (Instituto de Biologia, Universidade Federal do Rio de Janeiro, Rio de Janeiro).

#### *Rivulus cearensis*, new species (Fig. 1)

**Holotype.** UFRJ 6636, male, 26.8 mm SL; Brazil: Estado do Ceará: Município de São Gonçalo do Amarante: Pecém, 22°10'50"S 41°23'41"W; V. Vono, April, 2008.

**Paratypes.** UFRJ 6637, 2 males, 25.2-28.1 mm SL, and 2 females, 29.2-30.4 mm SL; UFRJ 6638, 1 male, 28.0 mm SL, and 2 females, 26.7-27.8 mm SL; all collected with holotype.

**Additional material (non types).** UFRJ 6582, 6; Brazil: Ceará: São Gonçalo do Amarante: Bom Jesus Farm; N. Ferreira Jr., 19 Dec. 2007.

**Diagnosis.** *Rivulus cearensis* is similar to *R. bahianus* and species of the *R. urophthalmus* group by all having the unique combination of ventral surface of head entirely scaled (vs. anterior portion of head ventral surface without scales) and flank with horizontal rows of small reddish brown or red spots in males (vs. horizontal rows of spots absent). *Rivulus cearensis* is distinguished from *R. bahianus* and species of the *R. urophthalmus* group by possessing iris green (vs. yellow) and by the absence of a ventral process on the post-temporal bone (vs. presence). The new species is similar to *R. bahianus* and distinguished from the species of the *R. urophthalmus* group by having fewer scales in the longitudinal series (34-35 vs. 37-50) and scales extending over 40-50 % of the caudal fin (vs. 25-30 %). *Rivulus cearensis* differs from *R. bahianus* in having a more robust body (body depth 22.5-23.8 % SL in males and 21.2-22.5 % SL in females, vs. 19.3-21.2 % SL and 19.1-20.9 % SL, respectively; caudal peduncle depth 15.2-15.9 % SL in males and 13.4-14.5 % SL in females, vs. 13.0-13.8 % SL and 11.9-13.4 % SL,

respectively; head width 80.1-81.0 % of head length (HL) in males and 82.8-84.3 % HL in females, vs. 72.8-78.7 % HL and 75.9-80.8 % HL, respectively), and possessing a broad dark red stripe on the dorsal margin and another on the ventral margin of the caudal fin in males (vs. both dorsal and ventral margins of the caudal fin with a yellowish white stripe).

**Description.** Morphometric data appear in Table 1. Largest male examined 28.1 mm SL; largest female examined 30.4 mm SL. Dorsal profile slightly convex, almost straight, from snout to end of dorsal-fin base, approximately straight on caudal peduncle. Ventral profile gently convex from lower jaw to anal-fin origin, nearly straight along caudal peduncle. Body slender, subcylindrical anteriorly, slightly deeper than wide, to compressed posteriorly. Greatest body depth just anterior to pelvic-fin base. Jaws short, snout blunt.

Extremity of dorsal and anal fins rounded in both sexes. Caudal fin elliptical. Pectoral fin rounded, its posterior margin reaching vertical anterior to pelvic-fin base, about 60 % of length between bases of pectoral and pelvic fins. Pelvic fin short, tip reaching between anus and urogenital papilla in males, anterior to anus in females. Pelvic-fin bases medially in contact. Dorsal-fin origin in vertical through base of 10th or 11th anal-fin rays, between neural spines of 21st and 22nd vertebrae. Anal-fin origin between pleural ribs of 14th and 15th vertebrae. Dorsal-fin rays 7-9; anal-fin rays 12-13; caudal-fin rays 29-30; pectoral-fin rays 13; pelvic-fin rays 6.

Scales large, cycloid. Trunk and head entirely scaled. No scales on dorsal and anal-fin bases. Scales extending over anterior 40 % of caudal fin. Frontal squamation E-patterned, frontal scales circularly arranged around A-scale without free margins; E-scales not overlapping medially; supraorbital scales 5. Longitudinal series of scales 34; transverse series of scales 8; scale rows around caudal peduncle 16. No contact organ on body and fins.

Cephalic neuromasts: supraorbital 3+3, parietal 2, anterior rostral 1, posterior rostral 1, infraorbital 1+14-16+1, preorbital 2-3, otic 1, postotic 1-2, supratemporal 1, median opercular 1, ventral opercular 1-2, preopercular 2+4, mandibular 4+1, lateral mandibular 2, paramandibular 1. One neuromast per scale of lateral line,

sometimes absent in few scales. Two neuromasts on caudal-fin base.

Basihyal subtriangular, greatest width about 45 % of length; basihyal cartilage about 20 % of total basihyal length. Six branchiostegal rays. Three teeth on second pharyngobranchial. Gill-rakers on first branchial arch 1+7. Vomerine teeth 5. Dermosphenotic present. Ventral process of posttemporal absent. Total vertebrae 32.

**Coloration.** Based on colour photographs taken in the field. Males. Side of body metallic light green, with seven horizontal rows of small dark red spots, of which four rows between anterior part of flank and vertical approximately through posterior end of anal-fin base, and three rows between anterior part of flank and caudal-fin base. Dorsum light brown. Venter white. Side of head and jaws light brown, opercular region bright green. Iris light green. Dorsal fin pale yellow, distal margin dark red. Anal fin yellow, with red dots on basal portion; narrow dark gray distal margin. Caudal fin pale yellow, with dark red broad stripe on dorsal margin and ventral margin, and narrow dark gray line along whole edge of fin. Pectoral fin yellowish hyaline. Pelvic fin pale orange with narrow anterior dark gray margin.

**Table 1.** Morphometric data of *Rivulus cearensis*. H, holotype.

	H UFRJ 6636	males (n=4)	females (n=4)
Standard length (mm)	26.8	25.2-28.1	26.7-30.4
<b>Percent of standard length</b>			
Body depth	22.8	22.5-23.8	21.2-22.5
Caudal peduncle depth	15.2	15.2-15.9	13.4-14.5
Predorsal length	78.6	78.6-85.3	79.3-84.2
Prepelvic length	57.1	54.4-58.6	55.0-59.3
Length of dorsal-fin base	9.5	8.6-9.5	8.0-9.1
Length of anal-fin base	20.6	18.9-20.6	18.8-19.3
Caudal-fin length	37.1	37.1-37.7	38.4-40.1
Pectoral-fin length	21.8	21.8-22.6	20.8-22.4
Pelvic-fin length	9.2	9.2-11.1	8.1-9.0
Head length	25.1	25.1-26.1	24.3-25.6
<b>Percent of head length</b>			
Head depth	68.8	66.7-70.0	67.6-69.2
Head width	81.0	80.1-81.0	82.8-84.3
Snout length	15.7	13.4-15.7	13.1-15.5
Lower jaw length	18.7	17.6-20.5	17.7-19.5
Eye diameter	34.3	30.5-34.9	30.6-33.0

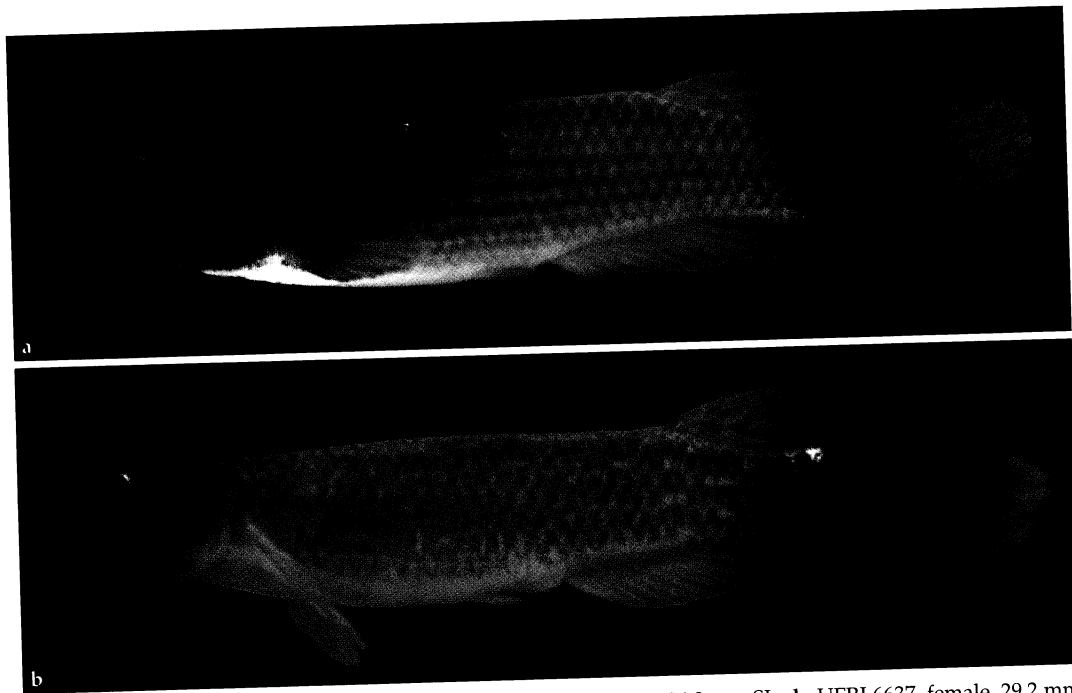


Fig. 1. *Rivulus cearensis* (preserved specimens); a, UFRJ 6636, male, 26.8 mm SL; b, UFRJ 6637, female, 29.2 mm SL; Brazil: Ceará: São Gonçalo do Amarante.

Females. Side of body light brownish gray, with small brown spots irregularly arranged or forming horizontal rows. Dorsum light brown. Venter white. Side of head orangish gray. Jaws light brownish gray. Iris light yellow. Unpaired fins yellowish hyaline, with dark brown dots; large, rounded black spot with narrow pale yellow outline on dorsal portion of caudal-fin base, slightly contacting dorsal margin of fin. Paired fins hyaline.

**Distribution and habitat.** *Rivulus cearensis* is known only from the type locality area, São Gonçalo do Amarante, Ceará, northeastern Brazil. It was found in a residual humid forest area inserted in the semi-arid savanna biome known as the Caatinga. The habitat of *R. cearensis* is a shaded, shallow, clear-water stream with light gray sand bottom.

**Etymology.** The name *cearensis* is a reference to the first record of the genus *Rivulus* for the Ceará state of Brazil.

### Discussion

Phylogenetic and biogeographic relationships among species of the several Neotropical killifish assemblages presently placed in *Rivulus* are way to be consistently determined. The occurrence of *R. cearensis* in an intermediate region between two areas inhabited by the best candidates to be its closer relatives, species of the *R. urophthalmus* group from the Amazon Forest and *R. bahianus* from the northern part of the Atlantic Forest, provides an interesting new data about geographic distribution. However, it does not elucidate the historical factors that have influenced the present day distribution, since relationships among species of *Rivulus* are contradictory or poorly understood (e.g., Murphy et al., 1999).

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