

Rivulus riograndensis, a new aplocheiloid killifish from southern Brazil (Cyprinodontiformes: Rivulidae)

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Rivulus riograndensis, a new species of the subgenus *Atlantirivulus* from the Patos lagoon basin and adjacent coastal plains, southern Brazil, is described. It is similar to *R. haraldsiolii* and *R. luelingi*, and distinguished from all other species of the subgenus, by having dark brown dots over the dorsal portion of the flank and dorsum in females. This unique color pattern suggests that *R. riograndensis*, *R. haraldsiolii* and *R. luelingi* form a monophyletic assemblage. The new species is distinguished from those two species by having fewer pelvic-fin rays and by the absence of contact organs on flank scales in males. It also differs from *R. haraldsiolii* by having fewer scales in the longitudinal series, fewer vertebrae, and dorsal fin more anteriorly placed on trunk, and from *R. luelingi*, by a different caudal-fin color pattern in males and by having more vertebrae.

Rivulus riograndensis, uma nova espécie do sub-gênero *Atlantirivulus* da bacia da lagoa dos Patos e planícies costeiras adjacentes, é descrita. Ela se assemelha a *R. haraldsiolii* e *R. luelingi*, e se distingue de todas as outras espécies do subgênero, por pontos castanho escuros sobre a porção dorsal do flanco e dorso em fêmeas. Este padrão de colorido exclusivo sugere que *R. riograndensis*, *R. haraldsiolii* e *R. luelingi* formam um agrupamento monofilético. A nova espécie se distingue daquelas duas espécies por possuir menos raios na nadadeira pélvica e pela ausência de órgãos de contato em escamas do flanco em machos. Ela também se distingue de *R. haraldsiolii* por possuir menos escamas na série longitudinal, menos vértebras e a nadadeira dorsal posicionada mais anteriormente no tronco, e de *R. luelingi*, por um padrão de colorido de nadadeira caudal diferente em machos e por possuir mais vértebras.

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Introduction

Rivulus is the most speciose and geographically widespread genus of the Rivulidae, with over 125 valid species occurring between Cuba and southern Brazil (Costa, 2008a). However, *Rivulus* possibly is not a monophyletic assemblage, but constitutes several basal, distinct lineages of the subfamily Rivulinae (e.g., Murphy et al., 1999). In southern Brazil, *Rivulus* is presently represented by three species: *R. santensis* occurring in São Paulo and Paraná states (Costa, 2008b), *R. luelingi* in Paraná and Santa Catarina states, and *R. haraldsiolii* in Santa Catarina state (Costa, 2007). All these species are placed in the subgenus *Atlantirivulus*, a well corroborated clade endemic to the coastal plains of Brazil (Costa, 2008c). A new species of *Atlantirivulus* from southern Brazil is herein described, expanding the known distribution of the subgenus by about 500 km southward.

Material and methods

Measurements and counts follow Costa (1995). Measurements are presented as percentages of standard length (SL), except for those related to head morphology, which are expressed as percentages 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 Museu de Ciências e Tecnologia da Pontifícia Universidade Católica, Porto Alegre (MCP) and Instituto de Biologia, Universidade Federal do Rio de Janeiro, Rio de Janeiro (UFRJ).

Rivulus riograndensis, new species

(Fig. 1)

Holotype. UFRJ 6639, male, 26.8 mm SL; Brazil: Estado do Rio Grande do Sul; Pai João swamp, Parque Nacional da Lagoa do Peixe, 31°3'24"S 50°49'40"W; L. E. K. Lanés, 31 October 2008.

Paratypes. Brazil: Estado do Rio Grande do Sul: UFRJ 6640, 1 male, 28.8 mm SL, 3 females, 22.6–28.3 mm SL; collected with holotype. – MCP 22485, 1 male, 29.3 mm SL, and 1 female, 33.9 mm SL; Município de Porto Alegre: stream in Praça Flávio Miranda, Parque Santa Fé, about 30°2'S 51°9'W; C. M. Joenck, 4 Jan 1999. – MCP 14977, 1 female, 24.1 mm SL; Lagoa da Emboaba, Osório, about 29°57'S 50°13'W; M. Christ, 10 Jun 1991. – UFRGS 6674, 2 males, 19.3–29.1 mm SL; stream tributary to Três Forquilhas river, near road RS-486, Terra de Areia, 29°33'22"S 50°4'19"W; L. R. Malabarba et al., 20 Oct 2003. – UFRGS 5809, 1 male, 23.7 mm SL, 1 female, 20.0 mm SL, and 7 juveniles of unidentified sex, 14.0–18.5 mm SL; plus 1 male, 21.3 mm SL, and 2 females, 18.5–19.9 mm SL (c&s); swamp at end of Trilha do Gaúcho, Mata do Faxinal, Torres; C. Agra et al., 28 Jul 2000.

Additional material (non types). Brazil: Estado do Rio Grande do Sul: UFRJ 6641, 7; collected with holotype. – MCP 13640, female, 17.2 mm SL; stream tributary to Quadros lagoon, near Barco beach, about 29°30'S 50°2'W; S. O. Kullander and MCP party, 1 Oct 1989.

Diagnosis. *Rivulus riograndensis* is distinguished from all other species of the subgenus *Atlantirivulus*, except *R. haraldsiolii* and *R. luelingi*, in having dark brown dots over the dorsal portion of the flank and dorsum in females (vs. absence). It differs from both *R. haraldsiolii* and *luelingi* by the absence of contact organs on flank scales in males (vs. presence of prominent contact organs) and in having fewer pelvic-fin rays (5 vs. 6). *Rivulus riograndensis* further differs from *R. haraldsiolii* by having fewer scales in the longitudinal series (31–32 vs. 35–36), fewer vertebrae (33 vs. 34–35), and the dorsal fin more anteriorly placed on trunk (in a vertical through the base of the 9th or 10th anal-fin ray, vs. through the base of the 12th or 13th anal-fin ray); differs from *R. luelingi* by having caudal fin light yellow with dark gray or black dorsal and ventral margins in males (vs. caudal fin dark red to black, with bright green submarginal band and black margin) and more vertebrae (33 vs. 31–32).

Description. Morphometric data appear in Table 1. Largest male examined 29.3 mm SL; largest female examined 33.9 mm SL. Dorsal profile weakly convex from snout to end of dorsal-fin base, nearly straight on caudal peduncle. Ventral

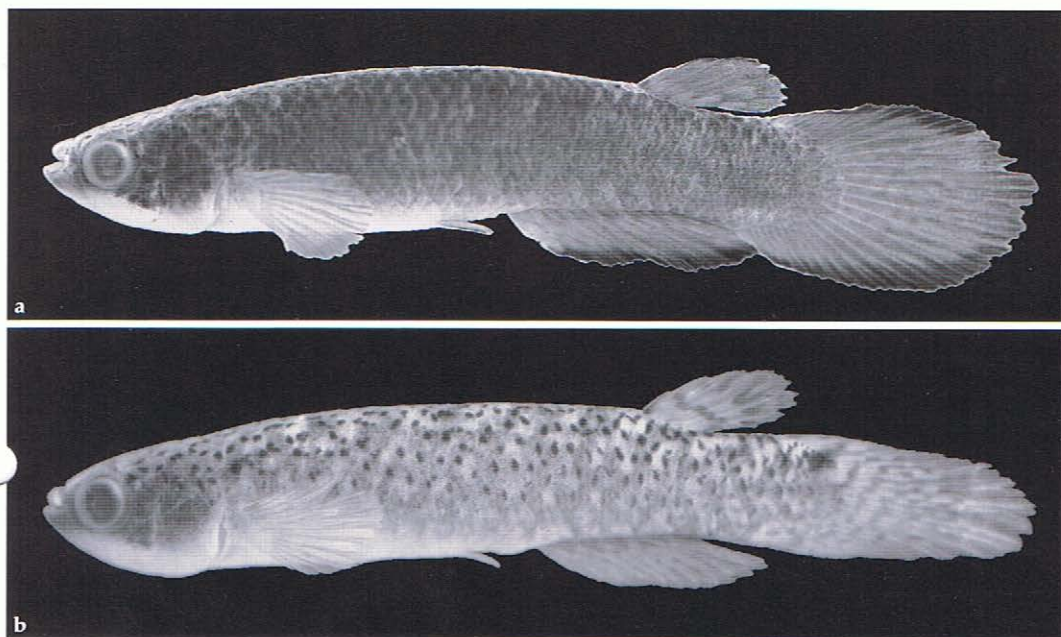


Fig. 1. *Rivulus riograndensis*; Brazil: Rio Grande do Sul: Parque Nacional da Lagoa do Peixe; a, UFRJ 6639, holotype, male, 26.8 mm SL; b, 6640, paratype, female, 28.3 mm SL.

profile about straight to slightly convex from lower jaw to end of anal-fin base, nearly straight on caudal peduncle. Body slender, subcylindrical anteriorly, slightly deeper than wide, to compressed posteriorly. Greatest body depth at vertical just in front to pelvic-fin base. Jaws short, snout blunt.

Extremity of dorsal and anal fins rounded. Caudal fin rounded. Pectoral fin rounded, posterior margin reaching vertical at about 70 % of length between pectoral-fin and pelvic-fin bases. Pelvic fin short and elliptical, tip reaching between anus and urogenital papilla in males, reaching anus in females. Pelvic-fin bases medially in contact. Dorsal-fin origin on vertical between base of 9th and 10th anal-fin rays, and between neural spines of 21st and 23rd vertebrae. Anal-fin origin between pleural ribs of 14th and 16th vertebrae. Dorsal-fin rays 8-10; anal-fin rays 14-16; caudal-fin rays 31-34; pectoral-fin rays 13-14; pelvic-fin rays 5.

Scales small, cycloid. Trunk and head entirely scaled, except anterior ventral surface of head. Body squamation extending over anterior 25 % of caudal-fin base; no scales on dorsal and anal-fin bases. Frontal squamation E-patterned; E-scales not overlapping medially; scales arranged

in regular circular pattern around A-scale without exposed margins; transverse row of scales ante-

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

	H UFRJ 6639	males (n = 5)	females (n = 5)
Standard length (mm)	26.8	23.7-29.3	22.6-33.9
Percent of standard length			
Body depth	21.4	21.1-23.2	20.1-23.7
Caudal peduncle depth	15.3	14.3-15.3	13.8-15.4
Predorsal length	79.9	76.8-81.2	77.0-81.8
Prepelvic length	54.2	54.2-56.1	55.1-59.0
Length of dorsal-fin base	9.6	9.6-11.3	9.2-10.8
Length of anal-fin base	24.2	20.2-24.2	19.3-22.1
Caudal-fin length	42.4	37.7-40.0	36.5-40.9
Pectoral-fin length	21.3	21.1-22.4	19.9-20.8
Pelvic-fin length	7.9	6.5-8.8	6.1-8.0
Head length	25.7	25.7-27.3	25.6-27.7
Percent of head length			
Head depth	69.7	65.6-71.6	67.6-71.4
Head width	79.6	75.9-79.6	76.1-81.8
Snout length	16.8	13.5-16.8	12.4-15.4
Lower jaw length	19.6	17.8-19.6	16.8-19.9
Eye diameter	32.6	32.6-34.7	31.0-36.3

rior to H-scale. Three to five supraorbital scales. Longitudinal series of scales 31-32; transverse series of scales 7-8; scale rows around caudal peduncle 16. No contact organs on scales and fins.

Cephalic neuromasts: supraorbital 3+3, parietal 2, anterior rostral 1, posterior rostral 1, infraorbital 1+19-21+1, preorbital 2-3, otic 1, postotic 2, supratemporal 1, median opercular 1, ventral opercular 1-2, preopercular 2+4, mandibular 4+2, lateral mandibular 2-3, paramandibular 1. One neuromast by scale of lateral line, sometimes neuromast absent in some scales; two neuromasts on caudal-fin base.

Basihyal subtriangular, greatest width about 45 % length; basihyal cartilage about 40 % of total basihyal length. Six branchiostegal rays. Two second pharyngobranchial teeth. Gill-rakers of first branchial arch 1+7. One vomerine tooth. Ventral process of posttemporal absent. Total vertebrae 33.

Coloration. Based on colour photographs taken in the field. Males. Side of body light purplish brown with pale yellowish green and pale pink oblique bars. Dorsum light brown. Venter light yellow. Side of head light brown, opercular region greenish golden, infraorbital region light yellow. Jaws dark gray. Iris light greenish yellow. Dorsal fin pale yellow with pale brown stripe on basal region. Anal fin pale yellow, basal portion light blue, with dark brown distal stripe. Caudal fin pale yellow, dark gray to black dorsal and ventral marginal stripes, ventral stripe slightly wider; pale yellow submarginal stripes on dorsal and ventral portions of fin. Pectoral fin yellowish hyaline. Pelvic fin yellow.

Females. Side of body light brownish gray, with brown marks forming reticulate pattern; dark brown dots on dorsal portion of flank. Dorsum light brown. Venter pale yellow. Side of head light brown, postorbital region dark brown, ventral portion of opercle pale golden, suborbital light yellow. Jaws gray. Iris light yellowish brown. Dorsal and caudal fins hyaline with transverse rows of small dark brown spots; small dark gray spot on dorsal portion of caudal fin base. Anal fin orangish hyaline with transverse rows of dark brown dots. Paired fins yellowish hyaline.

Distribution and habitat. Patos lagoon basin and adjacent coastal plains, Rio Grande do Sul state, southern Brazil. The type locality is a shallow pool, about 5-10 cm deep, with orangish hyaline water; it is situated in an open vegetation place at the border of a forest.

Etymology. The name *riograndensis* is an allusion to the occurrence in the Estado do Rio Grande do Sul, unique in the genus *Rivulus*.

Discussion

Rivulus riograndensis is a typical member of the subgenus *Atlantirivulus*, exhibiting both synapomorphies diagnosing the genus: numerous infraorbital neuromasts arranged in a zig-zag pattern and ventral process of angulo-articular curved (Costa, 2008b). However, relationships among species of *Atlantirivulus* are still poorly known. The few putative derived color pattern features shared by *R. riograndensis* and some congeners generate conflicting hypothesis. The color pattern of dark brown dots over the dorsal part of flank and dorsum in females, shared by *R. riograndensis*, *R. haraldsiolii* and *R. luelingi*, is unique among species of *Atlantirivulus*, thus supporting a clade comprising these three species. However, *R. riograndensis* and *R. haraldsiolii* share a derived color pattern consisting of caudal fin pale yellow with broad dark gray to black dorsal and ventral margins in males (Costa, 2008d), also occurring in *R. santensis*, *R. janeiroensis*, *R. jurubatibensis*, and *R. nudiventris*, but absent in *R. luelingi*. The latter species has another unique color pattern of caudal fin in males, in which the fin is dark red to black with bright green submarginal band and black margin, which could be interpreted as a secondary apomorphic condition, derived from the pattern shared by *R. riograndensis* and *R. haraldsiolii*. Although the putative clade comprising *R. riograndensis*, *R. haraldsiolii* and *R. luelingi* being geographically plausible by all the included species occurring in the southern-most portion of the geographic range of the subgenus, the available data are not sufficient to erect a consistent hypothesis of relationships among species of *Atlantirivulus*.

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