

***Rivulus kayapo* n. sp. (Teleostei: Cyprinodontiformes: Rivulidae):
a new killifish from the serra dos Caiapós, upper rio Araguaia
basin, Brazil**

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Abstract

Rivulus kayapo, new species, a member of the *Rivulus punctatus* species group from the rio Caiapó drainage, upper rio Araguaia basin, is described. It is similar to *R. pinima* by the absence of bars on the caudal fin and flank in both sexes, in having longitudinal rows of red dots along the entire flanks in both sexes, and in having longitudinally elongated white mark above the caudal spot in females. *Rivulus kayapo* differs from *R. pinima* in having more caudal-fin rays, the dorsal-fin origin more posteriorly placed, and fewer scales in the longitudinal and transverse series; and differs from all congeners of the *R. punctatus* species group by possessing a unique reticulate color pattern on the flanks in males. A key for identification of species of *Rivulus* from the rio Araguaia-Tocantins basin is provided.

Key words: Killifish, Cyprinodontiformes, Rivulidae, *Rivulus*, rio Araguaia, systematics, taxonomy, new species

Resumo

Rivulus kayapo, sp. nov., um membro do grupo de espécies *Rivulus punctatus* da drenagem do rio Caiapó, bacia do alto rio Araguaia, é descrita. Ela se assemelha a *R. pinima* pela ausência de barras na nadadeira caudal e flanco de ambos sexos, e por ter fileiras longitudinais de pontos vermelhos em todo o flanco em ambos sexos, e marca branca alongada longitudinalmente acima de mancha caudal em fêmeas. *Rivulus kayapo* difere de *R. pinima* por ter mais raios na nadadeira caudal, origem de nadadeira dorsal inserida mais posteriormente, e menos escamas nas séries longitudinal e transversal; e difere de todos os outros congêneres do grupo de espécies *R. punctatus* por possuir um padrão de colorido reticulado exclusivo no flanco em machos. Uma chave para identificação de espécies de *Rivulus* da bacia do rio Araguaia-Tocantins é fornecida.

Introduction

The killifish genus *Rivulus* Poey constitutes the most speciose and geographically widespread assemblage of aplocheiloid fishes. A great diversity in species of *Rivulus* has long been known from Central America and the northern part of South America, including river basins draining the Guyana Shield and the western portion of the Rio Amazonas basin (Costa, 2003, 2006). However, a rich diversity of species has only recently been reported for the central part of South America, including southern tributaries of the rio Amazonas (Tocantins, Araguaia, Xingu, and Tapajós) and the rio Paraná-Paraguay-Uruguay basin (Costa, 1995a, 2005). *Rivulus* is still a poorly diagnosed genus, but it contains well-corroborated monophyletic units. This is the case for an assemblage formerly known as the *Rivulus punctatus* species group (Costa, 1995a), now considered to comprise the subgenus *Melanorivulus* (Costa, 2006), a well supported clade endemic to central South America. This subgenus comprises 18 species: *Rivulus apiamici* Costa, *R. cyanopterus* Costa, *R. dapazi* Costa, *R. decoratus* Costa, *R. egens* Costa, *R. litteratus* Costa, *R. modestus* Costa, *R. paracatuensis* Costa, *R. parnaibensis* Costa, *R. pictus* Costa, *R. pinima* Costa, *R. punctatus* Boulenger, *R. rossoi* Costa, *R. rutilicaudus* Costa, *R. scalaris* Costa, *R. violaceus* Costa, *R. vittatus* Costa, and *R. zygonectes* Myers. A new species of this clade, collected in the rio Caiapó drainage of the upper Rio Araguaia basin, is herein described.

Material and methods

Measurements and counts follow Costa (1995b). 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 pectoral, pelvic 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 and Van Dyke (1985). Terminology for frontal squamation follows Hoedeman (1958) and for cephalic neuromast series follows Costa (2001). The abbreviation c&s denotes specimens that were cleared and stained for bone and cartilage. Material is deposited in MCP, Museu de Ciências e Tecnologia da Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, Brazil; and UFRJ, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil.

Rivulus kayapo, new species

(Figs. 1–2)

Holotype. UFRJ 6380 (male, 28.7 mm SL); Brazil: Estado de Goiás: stream near km 52 of

road GO-221, Rio Bonito drainage, upper Rio Caiapó basin (itself a part of the Rio Araguaia basin), 16°41'52.4"S, 51°25'13.6"W, altitude 685 m; W. J. E. M. Costa, C. P. Bove & J. Paz, 11 April 2006.

Paratypes. UFRJ 6381 (6 males, 21.2–27.1 mm SL; 6 females, 23.5–27.4 mm SL); UFRJ 6382 (3 males, 21.4–26.7 mm SL; 2 females, 22.4–25.3 mm SL) (c&s); MCP 40140, (2 males, 22.9–24.4 mm SL; 1 female, 23.0 mm SL); all collected with holotype.

Diagnosis. Distinguished from all other species of the *Rivulus punctatus* group in having a unique color pattern on flanks and caudal fin in males, consisting of: (a) flanks with red dots arranged in longitudinal rows, overlapping red dots arranged in oblique rows, which together form a red reticulate pattern, and (b) caudal fin golden, with red, vertically elongated spots on central portion of fin, light blue without marks on marginal zone (*vs.* never a similar color pattern). It differs from all species of the *R. punctatus* group except *R. pinima* in possessing longitudinal rows of red dots along the entire flanks (*vs.* longitudinal rows of red absent or vestigial and restricted to anterior portion of flanks), reduction of black pigmentation on head (*vs.* intensely pigmented), and presence of longitudinally elongated white mark above caudal spot in females (*vs.* absence). *Rivulus kayapo* is distinguished from *R. pinima* by having more caudal-fin rays (32–34 *vs.* 30–31), dorsal-fin origin on a vertical through base of 9th anal-fin ray (*vs.* between base of 7th and 8th anal-fin rays), and fewer scales in both longitudinal series (32–33 *vs.* 36–37) and transverse series (8 *vs.* 10).

Description. Morphometric data appear in Table 1. Males larger than females, the largest male examined 28.7 mm SL; largest female examined 27.4 mm SL. Dorsal profile slightly convex from snout to end of dorsal-fin base, nearly straight on caudal peduncle. Ventral profile gently convex from lower jaw to anal-fin origin, approximately straight to end of caudal peduncle. Body slender, compressed, the greatest body depth at level of pelvic-fin base. Snout short and rounded.

Dorsal and anal fins rounded and without filaments in both sexes. Pectoral fin rounded, its posterior margin reaching about 60–70 % of distance between pectoral and pelvic-fin bases. Pelvic fins short, slightly pointed in males, elliptical in females; tip of each pelvic fin reaching urogenital papilla in males and anus in females. Pelvic-fin bases medially in close proximity. Dorsal-fin origin on vertical through base of 9th anal-fin ray, between neural spines of vertebrae 19 and 20. Anal-fin origin between pleural ribs of vertebrae 14 and 16. Dorsal-fin rays 9–11; anal-fin rays 12–14; caudal-fin rays 32–34; pectoral-fin rays 13–14; pelvic-fin rays 7.

Scales large and cycloid. Body and head entirely scaled, except on ventral surface of head. No scales on dorsal and anal-fin bases. Scales extending on anterior 30% of caudal fin. Frontal squamation E-patterned; E-scales not overlapping; row of scales anterior to H-scale; three supraorbital scales. Longitudinal series of scales 32–33; transverse series of scales 8; scale rows around caudal peduncle 16. No contact organs on scales and fin rays.

Cephalic neuromasts: supraorbital 3 + 3, parietal 2, anterior rostral 1, posterior rostral

1, infraorbital 1 + 9 + 1 + 1, preorbital 2, otic 1, post-otic 2, supratemporal 1, median opercular 1, ventral opercular 1, preopercular 2 + 5, mandibular 4 + 1, lateral mandibular 1, paramandibular 1. Lateral line interrupted, with alternating sets of 3–4 scales with one neuromast and without neuromasts. Two neuromasts on caudal-fin base.

TABLE 1. Morphometric data for *Rivulus kayapo*.

	males (n = 10)	females (n = 9)
Standard length (mm)	21.2–28.7	22.4–27.4
Percentages of standard length		
Body depth	22.4–24.8	22.4–24.2
Caudal-peduncle depth	13.4–15.2	13.4–15.3
Predorsal length	76.4–79.1	77.0–79.8
Prepelvic length	57.2–59.0	57.6–59.0
Length of dorsal-fin base	11.0–12.2	9.8–11.2
Length of anal-fin base	17.3–20.1	16.2–18.4
Caudal-fin length	33.0–37.4	31.2–34.8
Pectoral-fin length	18.7–20.9	17.8–20.4
Pelvic-fin length	7.8–11.7	7.5–8.4
Head length	26.3–29.7	26.5–28.6
Percentages of head length		
Head depth	70.1–76.7	71.2–77.3
Head width	75.0–82.1	75.5–83.6
Snout length	12.8–15.1	12.6–15.5
Lower-jaw length	17.8–20.0	16.4–19.0
Eye diameter	30.1–35.3	31.6–34.6

Basihyal subtriangular, its greatest width about 50% 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 + 7. Vomerine teeth 4. Dermosphenotic present. Ventral process of posttemporal absent. Total vertebrae 31.

Coloration. Males. Sides of body golden to greenish golden, purplish blue above anal-fin base, with red dots arranged in longitudinal rows overlapping red dots arranged in oblique rows between vertical through pelvic-fin base and caudal-fin base, forming a red reticulate pattern. Dorsum light brown. Venter light gray. Sides of head golden. Jaws gray. Iris pale yellow. Dorsal fin light blue, with three transverse red stripes; basal portion golden. Anal fin light blue, with distal portion yellow, red stripe on fin base and transverse sub-basal row of red dots. Caudal fin golden, with red, vertically elongated spots on

central portion of fin and light blue without marks on marginal zone. Pectoral and pelvic fins yellowish hyaline.



FIGURE 1. *Rivulus kayapo*, UFRJ 6380 (male, holotype, 28.7 mm SL) (one day after collection); Brazil: Goiás: rio Caiapó drainage.



FIGURE 2. *Rivulus kayapo*, UFRJ 6381 (female, paratype, 27.4 mm SL) (one day after collection); Brazil: Goiás: rio Caiapó drainage.

Females. Sides of head and trunk light brown, with golden iridescence; two oblique rows of dark brown spots on opercular region and anterior portion of flank. Flanks with red dots simultaneously arranged longitudinally and in rows. Dorsum light brown. Venter light gray. Jaws gray. Iris pale yellow. Dorsal fins pale yellow, with faint brown spots; distal portion pale blue, with dark gray to black margins. Anal fin pale blue on basal and distal portions, pale yellow on middle portion, and dark gray to black distal margin. Caudal fin pale yellow, with faint brown spots, posterodistal portion pale blue; dark gray to black margin; black spot, dorsally margined by white zone, on dorsal portion of caudal-fin base. Pectoral and pelvic fins yellowish hyaline; anterior margin of pelvic fin dark gray to black.

Distribution and habitat. Known only from the type locality, a small stream draining the serra dos Caiapós, upper rio Araguaia basin, in a savannah area (Fig. 3). Adult

specimens were collected along the stream margin, about 30 cm deep; and juveniles were found in adjacent floodplains, about 3 cm deep. At the stream margin, the water was clear, 26.2°C at 5:00 PM, and pH 5.40. The only other fish species collected was *Aspidoras sp.* (Siluriformes: Callichthyidae).

Etymology. Kayapó is the name of an indigenous tribe of people inhabiting the hills where the new species was collected, locally named serra dos Caiapós.



FIGURE 3. Stream in serra dos Caiapós (type locality of *Rivulus kayapo*); Brazil: Goiás: rio Caiapó drainage.

Discussion

Rivulus kayapo is a member of an assemblage known as the *Rivulus punctatus* species group (Costa, 1995a; 1998), diagnosed by several synapomorphies, including dorsal portion of preopercle short and pointed, two black oblique bars or rows of spots on the post-orbital region, melanophores concentrated on margins of unpaired and pelvic fins in females, and females with a black spot on the upper portion of caudal fin separated from caudal-fin margin (Costa, 1998, 2006). Among species of this group, a subgroup comprising species endemic to the central Brazilian plateau (*Rivulus apiamici*, *R. egens*, *R. litteratus*, *R. pictus*, *R. pinima*, *R. rutilicaudus*, *R. scalaris*, and *R. vittatus*) is diagnosed by two apomorphic features: ventral process of angulo-articular vestigial (Costa, 1998, 2006) and flank greenish golden to metallic greenish blue in males (Costa, 2005, 2006). *Rivulus kayapo* exhibits both apomorphic features of the central Brazilian plateau clade.

Although a study on phylogenetic relationships among species of the *R. punctatus*

group is beyond the scope of the present paper, some remarkable unique features shared by *R. kayapo* and *R. pinima* suggest a close relationships between these two species. These include: presence of longitudinal rows of red dots along entire length of both flanks (*vs.* longitudinal rows of red dots, when present, is vestigial, and restricted to anterior portions of flanks); absence of red bars on caudal fin and oblique bars on flanks of both sexes (*vs.* presence); reduction of black pigmentation on head (*vs.* intensely pigmented); and presence of longitudinally elongated white mark above the caudal spot in females (*vs.* absence).

Besides *R. kayapo*, two species of *Rivulus* are known to occur in the rio Araguaia basin: *R. litteratus*, a species of a central Brazilian plateau clade, endemic to the upper section of the main channel of the Rio Araguaia (Costa, 2005), and *R. zygonectes*, a species with a broad geographic distribution in the Araguaia, Tocantins, Xingu and Tapajós river basins (Costa, 1995a). They may be distinguished according to characters presented in the key below.

Key to species of *Rivulus* from the Rio Araguaia-Tocantins basin

- 1a. 31-33 scales in longitudinal series; ground color of flanks metallic green to greenish golden in males; no dark gray stripe along flank in males..... 2
- 1b. 33-35 scales in longitudinal series; color ground of flanks light brown to pale purplish brown in males; dark gray stripe along flank in males, most visible when live individuals are exposed to sunlight *R. zygonectes*
- 2a. Dorsal-fin origin on vertical through base of 7th or 8th anal-fin ray; tip of each pelvic fin reaching base of 1st or 2nd anal-fin ray in males; frontal squamation F-patterned; red bars and spots on flanks in males; bars on caudal fin in both sexes *R. litteratus*
- 2b. Dorsal-fin origin on vertical through base of 9th anal-fin ray; tip of each pelvic fin reaching urogenital papilla in males; frontal squamation E-patterned; red reticulate pattern on flank in males; no bars on caudal fin *R. kayapo*

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