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Rivulus sape, a new species of killifish (Cyprinodontiformes: Rivulidae) from the Paragua River system, Caroní River drainage, Guyana Shield, Venezuela

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Abstract

A new species, *Rivulus sape*, is described from two tributaries of the upper Paragua River, Caroní River drainage, of the Guyana Shield in Venezuela. It is a small (all specimens examined less than 50 mm SL), apparently non-annual species that is distinguished from congeners in having the dorsal, anal, and pelvic fins short; adult males with a truncate caudal fin with the upper and lower borders black; and an iridescent blue, ovate spot on sides of the body above the pectoral fins. Neither adults nor juveniles have an ocellus at the dorsal junction of the caudal peduncle and caudal fin. Only one contact organ per scale on some scales along the sides of the body was observed.

Key words: Fish, Killifish, *Rivulus*, Rivulidae, Caroní River drainage, Orinoco River basin, Guyana Shield, Venezuela

Resumen

Se describe una nueva especie, *Rivulus sape*, proveniente de dos afluentes del alto río Paragua (cuenca del río Caroní), en la Guayana Venezolana. Es una especie de pequeño tamaño, (todos ejemplares examinados fueron menores de 50 mm LE) aparentemente no anual, que se diferencia de otras especies del género por tener las aletas dorsal, anal y pélvicas cortas; la aleta caudal truncada con los bordes superiores e inferiores negros, y por tener una mancha ovalada azul oscura en la región superior de la aleta pectoral en los machos adultos. Ni en adultos ni juveniles hay una mancha negra ocelada en la base de la aleta caudal. Se observó la presencia de un solo órgano “de contacto” por escama en algunas de las escamas de los costados del cuerpo.

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Introduction

The killifish genus *Rivulus* Poey, 1860 (Cyprinodontiformes: Rivulidae) is widely distributed in both Middle and South America, where it ranges from Mexico to Argentina, and on many Caribbean islands from Cuba to Trinidad. There are more than 100 recognized species in the genus, making it the most speciose genus in the family. Although additional species continue to be found and described, only Huber (1992) has cataloged their diversity, ecology, and distribution patterns, along with their taxonomy. Phylogenetic studies of rivulids, including the genus *Rivulus*, reveal that it is polyphyletic, based on molecular sequence data (Hrbek and Larson, 1999; Murphy *et al.*, 1999), but monophyletic if only morphological data are considered (Costa, 1998; Hrbek *et al.*, 2004). Based on maximum body size, adult color pattern and habitat preference *Rivulus sape* would belong to the Guyana Shield species group, as proposed by Hrbek and Larson (1999), but confirmation of this awaits DNA analyses. Generally speaking, species of this clade are small (i.e., usually less than 50 mm SL, although some, such as *Rivulus tecminae*, attain larger sizes) brightly colored fishes that typically exhibit less sexual dimorphism than most *Rivulus* species and usually inhabit very small, clear-water streams or temporary isolated pools that are often devoid of other fish species (Hrbek *et al*., 2004). Exceptions exist for each of these conditions, however.

The upper Caroní River, including its principle tributary the Paragua River, represents one of the most remote and ichthyologically unknown regions remaining in Venezuela. This drainage interdigitates, to the east, with the upper Cuyuní River, a tributary of the E ssequibo River that flows into neighboring Guyana; to the south with the upper Branco River, an Amazon River tributary; and to the west with the Caura River, another Orinoco tributary.

We collected fishes as part of an AquaRAP (Aquatic Rapid Assessment Program, December 2005) survey of the region. During our survey we discovered the new *Rivulus* described in this paper, as well as another, more robust species of killifish that may also be new. A report on the complete findings of the survey is in press. A preliminary count suggests that as many as one hundred species of fishes were obtained.

Methods

Measurements were taken with digital calipers, and follow Hoedeman (1959), with the exception of head width, which was measured from the tip of the snout to the posterior margin of the preopercle; and greatest body depth (GBD), which was measured at the origin of the anal fin. We also included the length of the caudal peduncle (CPL), measured from the posterior edge of the anal fin base to the midbase of the caudal fin. Measurements are expressed as thousandths of standard length. The color descriptions are based on photographs, live specimens maintained in aquaria, and freshly preserved material.

Abbreviations for institutions follow Leviton *et al*. (1985), with the addition of Museo de Historia Natural La Salle, Caracas, Venezuela (MHNLS).

***Rivulus sape,* new species**
Figures 1, 2 and 3; table 1.

Holotype. MHNLS 18934, adult male, 47.7 mm SL; Venezuela: Orinoco River basin, Caroní River system, small stream, a tributary entering the right side of the Ichún River, downstream from Ichún, or Espuma Falls, tributary of the Paragua River, Bolívar state, approximately 04°46'04"N, 63°27'57"W, 340 m a. s. l.; C. Lasso, O. León-Mata, and J. Mora; 4 December 2005.

Paratypes. All from Venezuela, Orinoco River basin, Caroní River system, Bolívar state. All collected with the holotype unless otherwise indicated. MHNLS 18935, four males, 15.7–31.3 mm SL; MHNLS 18936, six females, 18.4–27.1 mm SL. MCNG 54730, two males, 20–26.2 mm SL, and two females, 23.6–25.7 mm SL. MBUCV-V-32971, one male,18.5 mm SL, and two females, 21–24.8 mm SL. ANSP 182913 two males 16.6–21.6 mm SL and two females, 20.9–24.3 mm SL. MCNG 54731 three males 21.0–24.1 mm SL and four females 19.3–31.6 mm SL, collected with holotype and kept alive; later preserved in 95% ethyl alcohol. MHNLS-18937, one female, 15.1 mm SL; Waimesapakén Creek, right bank tributary of the Paragua River, downstream from CVG-EDELCA camp in Karún, approximately 05°19'42"N, 63°24'57"W; 320 m a. s. l.; C. Lasso, O. León-Mata and J. Mora; 2 December 2005.

Diagnosis. Differs from other species of *Rivulus* by the following combination of characters: dorsal, anal, and pelvic fins short in males; caudal fin truncate, with upper and lower edges black in adult males; a large iridescent blue horizontally ovate spot present on sides of body above and behind pectoral fin in males; ocellated caudal spot absent in all individuals examined only one contact organ per scale, present on some scales of flanks.

Description. Meristic and morphometric data for holotype and 20 paratypes are given in Table 1.

A small species of *Rivulus* (mean [including holotype]: 23.5 mm SL). Figures 1 and 2 show the sexual dimorphism apparent in this species, which includes differences in color of body and fins, and shape of the caudal fin. Fins short, the pectorals not reaching origin of pelvics, and pelvics not reaching origin of anal fin. Dorsal and anal fins not reaching base of caudal fin. Only in two males, 33.8 and 34 mm SL, did pelvic fins reach anal-fin origin, and folded dorsal just barely touching base of caudal fin. Caudal fin truncate in adult males over 25 mm SL (figure 1), rounded in smaller males and in all females (figures 2 and 3). All fins without filaments or extensions. Caudal peduncle relatively deep (mean = 0.13 SL). Head squamation pattern similar to F-scale pattern of Hoedeman (1958) and Thomerson *et al.* (1992) and further described by Huber (1992) as S-pattern. Two or three scales extending into caudal fin after termination of lateral scale series. One contact organ per scale present on some scales of the lateral series on sides.

TABLE 1. Counts and Measurements of *Rivulus sape*.

		males, n = 7			females, n = 13		
	Holotype	low	high	mode / mean	low	high	mode / mean
Standard length	40.7	15.7	31.3	22.7	18.4	27.0	22.6
Meristic							
Dorsal rays	8	7	8	8	7	8	7
Anal rays	12	10	12	12	9	12	11
Pectoral rays	14	13	14	13	13	14	13
Pelvic rays	6	6	6	6	6	6	6
Lateral scales	36	32	36	35	32	35	33
Transverse scales	11	9	11	10	9	11	9
Caudal peduncule scales	16	13	16	14	13	16	15
Breast scales	11	7	10	8	8	9	9
Thousandths of standard length							
Total length	1.200	1.164	1.295	1.257	1.196	1.303	1.260
Greatest body depth	0.096	0.172	0.255	0.214	0.187	0.214	0.198
Caudal peduncule depth	0.129	0.121	0.141	0.131	0.115	0.134	0.127
Caudal peduncule length	0.110	0.161	0.214	0.189	0.156	0.214	0.182
Head width	0.167	0.170	0.199	0.179	0.178	0.199	0.186
Head depth	0.144	0.133	0.154	0.142	0.131	0.151	0.143
Head length	0.237	0.250	0.309	0.273	0.258	0.285	0.270
Snout length	0.050	0.037	0.072	0.057	0.046	0.072	0.057
Eye diameter	0.078	0.082	0.103	0.091	0.084	0.103	0.094
Predorsal length	0.735	0.709	0.768	0.736	0.695	0.767	0.734
Preanal length	0.615	0.594	0.839	0.611	0.602	0.839	0.638
Dorsal fin base length	0.091	0.080	0.105	0.091	0.075	0.105	0.093
Anal fin base length	0.147	0.138	0.171	0.151	0.113	0.171	0.142
Dorsal fin length	0.152	0.134	0.253	0.173	0.114	0.193	0.152
Anal fin length	0.179	0.140	0.301	0.192	0.140	0.265	0.177
Pectoral fin length	0.151	0.158	0.209	0.188	0.162	0.202	0.183
Pelvic fin length	0.082	0.084	0.116	0.099	0.066	0.111	0.090

Life colors (adult males). See Figure 2. Body light brown, darker brown on dorsum, tan, pink to white on belly. The outstanding feature of adult males is a bright, shiny, horizontally ovate sky-blue spot, just above and behind pectoral fin base and posterior to opercle. Apparently depending on lighting, mood and maturity of the individual fish, the

scales on remainder of lateral sides show bright, shiny blue pigment, which in intensely colored fish can cause the sides to become an almost solid shiny blue, or in pale individuals can be reduced to the center of just a few shiny scales on posterior portion of body, sometimes aligned into chevron patterns that open posteriorly. Dorsum shiny golden in brightly colored fish, yellow or tan in less intensively colored individuals; in the latter, a series of brown spots may be present from above eye and along dorsum to caudal peduncle. In some males there is a patch of shiny golden to yellow pigment just anterior to the blue patch on upper part of opercle and anterior part of flank. Head golden or tan above, cheek tan or pale white, sometimes with shiny blue streaks. Eye yellow, golden or whitish, with a darker brown arc on upper edge. Dorsal fin with three or four alternately angled horizontal rows of light and dark spots; the dark spots often wine-red or reddish brown, the light spots yellow or shiny blue. Caudal fin with alternating semi-circular rows of reddish and shiny blue spots, and edged dorsally and ventrally with a jet-black band. In some individuals the rear margin of this fin is yellowish, and in other reddish. In less intensively colored fish, caudal fin with pink fin rays, interspersed with clear membranes. Anal fin white or pink along base, anterior portion bright yellow or golden, rear portion blue-green or blue; many individuals with one or more rows of reddish spots parallel to fin base. Anal fin edged in black in some individuals. Ventral fins blue or green, with yellow or shiny blue spots. Pectorals fin clear.

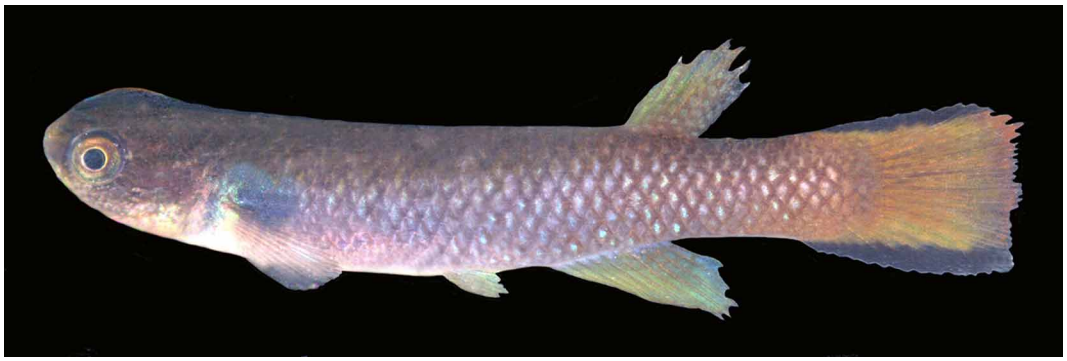

FIGURE 1. Photo of *Rivulus sape* MHNLS 18934 (male holotype, 47.7 mm SL).

Life colors (adult females). See Figure 2. Females have a color pattern similar to adult males, but with colors much more subdued. Body basically colored tan or brown, darker dorsally, fading to pink or white on belly. Some scales on dorsum with dark brown centers that form an irregular row from eye to caudal peduncle along dorsum. Flanks with three to six rows of light scales, whitish or light blue. Intense spot of centrally located pigment posterior to opercle either greenish, bluish or golden, and sometimes absent in frightened individuals or in fish kept in intense light. Eye golden or white, darker dorsally. Dorsal fin with rows of light yellow, blue or green spots, alternating with darker rows of brown or reddish spots. Caudal fin lacking the black stripes seen in males, yellowish or

clear with flecks of shiny yellow, blue or green. Anal fin yellowish, in some individuals green anteriorly and blue posteriorly, with faint rows or brown spots on membranes between rays. Ventral fins yellowish, green or blue. No 'rivulus' spot present at any life stage.

Distribution. Known only from the type locality and surrounding area within the Paragua River system of the upper Caroni River drainage, Orinoco River basin, within Bolívar State, Venezuela. Documented localities include two small tributaries of the Ichún River, which flows into the Paragua River, and Waimesapakén Creek, also a tributary of the upper Paragua.

Habitat. *Rivulus sape* was collected from isolated pools (about 5 cm depth) of the flooded margins of small clear-water creeks situated over a sandy to muddy substrate with abundant leaf litter. The water temperature was 24°C; the pH was acidic (between 4.5 and 5.2) and saturated with oxygen (7.3 to 7.4 mg/l); with very low conductivity (between 9.8 and 16.3 microsiemens/cm).

Etymology. This species is named to honor the local indigenous people of the Sapé tribe, inhabitants of the upper Paragua River system, Caroní River drainage, where the fish was collected.

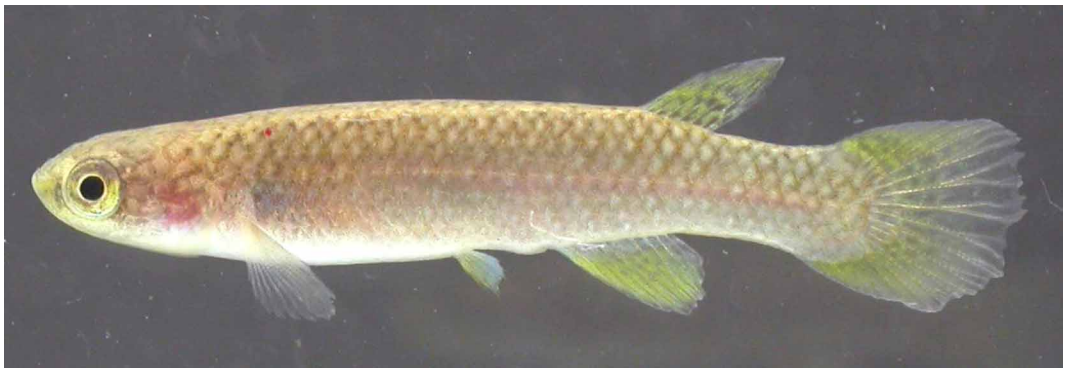

FIGURE 2. *Rivulus sape*, adult female (approximately 30 mm SL). Not included in type material.

FIGURE 3. *Rivulus sape*, juvenile male (approximately 25 mm SL). Not included in type material.

Discussion

Rivulus sape is the fourth species of *Rivulus* described from the Caroní River drainage. The other members of the genus known from the Caroní drainage are *Rivulus lyricauda* Thomerson, Berkenkamp and Taphorn, 1991, described from the Carrao River in the vicinity of Canaima; and *Rivulus gransabanae* Lasso, Taphorn and Thomerson, 1992, described from the elevated plains of the Gran Sabana. The remaining species, *Rivulus deltaphilus* Seegers, 1983, in contrast to the other three *Rivulus* species mentioned, is found in lowland regions of the lower Orinoco River floodplains, including the lower Caroní River (Lasso *et al.*, 2005). The relatively deep caudal peduncle of *Rivulus sape* (mean in males 0.131, females: 0.127, given as thousandths of SL) is shared with *R. lyricauda* (mean 0.146 in males, and 0.134 in females) and *R. gransabanae* (mean 0.150 in males, and 0.140 in females), as are the truncate caudal fin in males, and their relatively small body size. It differs from these two species, however, in lacking the filamentous extensions of the fin rays of the ventral, dorsal and caudal fins; in having more lateral scales (32–36) than all other species except *R. lyricauda* (29–32), as well as shorter dorsal and anal fins, (mean = 0.173 in males, and 0.152 in females of *R. sape*, males 0.231 and females 0.210 in *R. lyricauda*, and males 0.282 and females 0.240 in *R. gransabanae*)**.** No other killifish has the distinctive blue spot observed on the body of *R. sape* or the color pattern in the caudal fin of adult males, which consists of black stripes along the upper and lower margins, with the center filled with red and blue mottling. These features distinguishes it from *R. gransabanae*, which has a dusky caudal fin with a metallic blue stripe; as well as *R. lyricauda*, in which the distinctively lyre shaped caudal fin has yellow or blue filaments extended above and below that are narrowly edged with black, but in which the distal margin is edged with black and shows an orange crescent along its base. In marked contrast to *R. sape*, *Rivulus deltaphilus* has white stripes along the dorsal and ventral margins of the caudal fin and reaches a much larger size as adults (more than 50 mm SL). Male *R. deltaphilus* also have about six series of red dots along the sides, and females have an ocellus on the dorsal portion of the caudal peduncle.

The contact organs observed on some scales of the lateral series in *Rivulus sape* have also been observed in *Rivulus immaculatus* Thomerson, Nico and Taphorn, 1991, a species described from the Venamo River, a tributary of the Cuyuní River of the Essequibo River basin. In that species, however, there are two or three contact organs per scale instead of just one per scale, as seen in *R. sape*. *Rivulus immaculatus* also shares the short dorsal, anal, and pelvic fins, and black borders of the caudal fin observed in *R. sape*, but differs in having seven pelvic-fin rays instead of six as seen in *R. sape*, in having a rounded caudal fin in males, and females with a heavily spotted body and fins.

The truncate caudal fin shape of males, an important character in this group, is also seen in other Guyana Shield *Rivulus* species, including *Rivulus tecminae* Thomerson, Nico and Taphorn, 1992, which was described from the Sipapo River of the upper Orinoco basin, and *Rivulus torrenticola* Vermeulen and Isbrücker, 2000, described from the

Kamarang River system of the Mazaruni-Essequibo drainage in Guyana. *Rivulus sape* can be differentiated from those species by: the absence of an imbricate head scale pattern (which is characteristic of *R. tecminae*); presence of short pelvic fins, in which the tips of the rays do not reach the anal-fin insertion; and by the presence of six pelvic-fin rays (seven in *R. torrenticola*). There are also notable differences in color pattern. *R. tecminae* has green stripes of varying thickness (thickness of stripes depending upon gender) over a reddish background along the sides of the body; the caudal fin of males with a yellow ventral border; and a large, ocellated black spot at the base of the caudal fin of females. In *R. torrenticola* the caudal fin is translucent, with a reddish dorsum and ventrum.

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