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Rivulus lyricauda, a new species from the Guyana Shield in Eastern Venezuela (Cyprinodontiformes: Rivulidae)

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Rivulus lyricauda, new species, a small non-annual species, is described from Canaima and vicinity in the upper Rio Caroni drainage, Bolivar State, Venezuela. Males develop extensions of dorsal and ventral caudal-fin rays to form a lyretail. Large males have one or two contact organs on lateral body scales. Females have no rivulus spot. Both sexes have a lateral pattern, more developed in males, of red dots, blotches and reticulations. A broad dark lateral stripe develops during stress or sexual excitement. Eggs are 2.1 mm diameter.

Se describe *Rivulus lyricauda*, una pequeña especie no anual, de Canaima en la cuenca del Río Caroní, en el estado Bolivar de Venezuela. Los machos se caracterizan en tener extensiones filamentosas de los radios dorsales y ventrales de la aleta caudal, que forman una lira, y por tener dos o tres órganos de contacto en cada escama de los costados. Las hembras carecen de la mancha ocelada en el pedúnculo caudal superior que tipifica la mayoría de las hembras del genero *Rivulus*. Ambos sexos tienen los costados marcados con puntos, manchas iregulares, o reticulaciones del color de sangre, (este caracter es más desarrollado en los machos). En peces sexulamente exitados o asustados se observa una franja ancha horizontal oscura. Los huevos son de 2,1 mm en diámetro.

Introduction

In 1968, E. (Leo) Hoigne collected a number of juvenile *Rivulus* from the stream that flows below the guest houses at Campamiento Canaima, Bolivar State, Venezuela. He reared several of these juveniles to sexual differentiation, and photographed them before preserving them. These photographs have interested aquarists and ichthyologists ever since (Fels & de Rahm, 1982, p. 102, for example) because they depicted a new and unusual *Rivulus* species. Juveniles collected in 1989 have been reared to maturity, and provided the holotype and seven of the paratypes of the new species described below.

Material and methods

Standard length (SL) is used throughout. Counts and measurements were made following Hoedeman (1959), with the exception that head depth (HD) was measured at the posterior margin of the preopercle. Measurements in addition to those taken by Hoedeman include prepelvic-fin insertion length (PP2L), snout length (SnL), and

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Fig. 1. Live wild caught topotypic adult male *Rivulus lyricauda*, approximately 40 mm SL.

orbit diameter (OD). GBD is greatest body depth as measured by Hoedeman; and BD is body depth at the anal-fin insertion. Measurements were made with Helios dial calipers to 0.1 mm, and ratios are expressed in thousandths. Fin ray counts were made on preserved specimens using a dissecting microscope with light transmitted through the fins, and include all discernible fin rays. Three paratypes were cleared and stained following Dingerkus & Uhler (1977). Color descriptions are based on observation and photographs of wild caught fish both in the field and reared to adulthood in the aquarium. Institutional abbreviations follow Leviton et al. (1985).

Fig. 2. Live wild caught topotypic adult female *Rivulus lyricauda*, approximately 36 mm SL.

Rivulus lyricauda, new species
(Figs. 1 - 3)

Holotype. MCNG 21714, male, 41.0 mm; small stream draining morichal swamp below guest houses at Campamiento Canaima, trib. to Rio Carrao, Rio Caroni Basin, Bolivar State, Venezuela, 06°15' N 62°48' W; L. Nico and L. Delashmit, 22 IV 1989, Field # LN 89-35.

Paratypes. MCNG 21715, female, 33.2 mm; same data as holotype. - MCNG 21716, 5 juveniles, 13.6-18.1 mm; same locality as holotype; E. Hoigne, 10 II 1968. - MCNG 21703, female, 23.8 mm; cleared and stained, same locality as holotype; J. Thomerson and D. Myer, 15 VII 1987. - MCNG 22120, 5 juveniles, 13.8-17.5 mm; same data as holotype. - MBUCV 20290, 3 males, 30.3-36.3 mm; 1 female, 32.6 mm; same data as holotype. - MBUCV 20280, 4 juveniles, 12.6-20.1 mm; same locality as holotype; E. Hoigne, 10 II 1968. - FMNH 99512, 2 males, 32.1 and 29.5 mm; 3 females, 33.8-33.5 mm; 1 juvenile, 17.5 mm; same locality as holotype; E. Hoigne, 10 II 1968. -

Fig. 3. Live wild caught topotypic male *Rivulus lyricauda*, approximately 40 mm SL; same male as Figure 1, showing stress pattern.

SMF 18437, male, 24.7 mm; and SMF 18435, male, 23.2 mm; small stream near village of Ravac, by airport at Canaima; K. Lung, 7 X 1989. - SMF 18436, female, 30.0 mm; and SMF 18437, female, 32.6 mm; same data as holotype. - MCNG 27305, 20, 17.1-25.1 mm; morichal at EDELCA camp at Arekuna, about 25 km N of Canaima, 6°30' N 62°53' W; D. Taphorn, J., and K. Thomerson, 3 VII 1990, Field # DCT 90-5. - MCNG 23709, 2, 15.0-19.9 mm; stream at EDELCA water intake, W of EDELCA camp at Canaima, 6°13'50" N 62°51'40" W; D. Taphorn and J. Thomerson, 4 VII 1990, Field # DCT 90-6. - MCNG 23710, 9, 15.8-21.9 mm; morichal about 2 km N of EDELCA camp at Canaima, 6°14' N 62°51'40" W; D. Taphorn, J., and K. Thomerson, 4 VII 1990, Field # DCT 90-7. - SCN 282, 1, ? mm; Rio Uruyen, S of Auyantepuy, Rio Marcha (?), alt. 460 m; A. Fernandez Yepez, F. Fernandez-Yepez, C. J. R., 28 IV 1956. - SCN 286, 2, 19.8-31.0 mm; Rio Guayaraca, S of Auyantepuy, alt. 980 m; A. Fernandez Yepez, F. Fernandez Yepez, C. J. R., 24 IV 1956.

Diagnosis. Differs from all known species of *Rivulus* Poey, 1860 by the elongation, in males, of the dorsal and ventral caudal-fin rays to form a lyretail.

Description. A small species of *Rivulus*; both sexes become sexually mature by 25 mm SL. Eggs are approximately 2.1 mm diameter and show normal development without diapauses. Morphometric values for the holotype and ranges and averages of values for holotype and 13 paratypes from the type locality are given in Table 1. Development of the lyretail in males is reflected in the higher TL/SL ratios for males. Males have elongated dorsal, anal, and pelvic-fins in comparison to females, but both sexes have short, rounded pectoral-fins. Males have a relatively deeper caudal peduncle than females, and this characteristic is most developed in dominant males. Both sexes have a convex belly profile and GBD is notable larger than BD for large sexually mature individuals, regardless of sex, but this may be a result of almost a year of life in the aquarium.

Meristic values for the holotype are indicated with *; number of individuals with each value is given in parenthesis after the value: lateral scales 29(2), 30(4), 31*(6), 32(2); predorsal scales 21*(6), 22(5), 24(2); transverse scales 8*(9), 9(3), 10(2); dorsal-fin rays 8(7), 9*(12), 10(3); anal-fin rays 11(1), 12*(10), 13(10), 14(2); pectoral-fin rays 13*(12), 14(12), 15(1); pelvic-fin rays 5(2), 6*(14), 7(4). Four individuals had 'e' head scale patterns, the holotype had 'd-e', one paratype had 'f-e', two had 'e' on one side and the other side dam-

Table 1. Proportional measurements for holotype and twelve additional paratypes of *Rivulus lyricauda*.

Character sex	Holotype male	MAX	(AVG) eight males	MIN	MAX	(AVG) six females	MIN
SL mm	41.0	41.0	(31.6)	23.2	33.8	(32.6)	30.0
TL/SL	1.30	1.32	(1.27)	1.22	1.25	(1.22)	1.19
PDL/SL	.695	.724	(.702)	.684	.718	(.698)	.681
PAL/SL	.617	.656	(.621)	.605	.638	(.612)	.592
PP2L	.473	.553	(.519)	.473	.555	(.506)	.472
HL/SL	.237	.250	(.243)	.237	.237	(.231)	.212
P1L/SL	.161	.178	(.160)	.142	.172	(.159)	.125
P2L/SL	.105	.116	(.091)	.075	.090	(.078)	.068
DB/SL	.100	.105	(.097)	.088	.107	(.093)	.083
DL/SL	.305	.305	(.231)	.149	.220	(.210)	.199
AB/SL	.166	.172	(.158)	.144	.160	(.150)	.133
AL/SL	.368	.368	(.302)	.225	.239	(.230)	.218
GBD/SL	.261	.261	(.219)	.195	.239	(.216)	.169
BD/SL	.227	.227	(.205)	.194	.206	(.198)	.187
CPD/SL	.171	.152	(.146)	.125	.144	(.134)	.115
OD/HL	.289	.350	(.270)	.145	.333	(.255)	.143
HW/HL	.918	.875	(.784)	.672	.942	(.835)	.725
HD/HL	.722	.753	(.703)	.637	.768	(.711)	.662
SnL/HL	.134	.167	(.126)	.068	.150	(.121)	.104

aged, one had a circular overlapping pattern with the left 'e' scale uppermost, two had circular overlapping patterns with one 'g' scale uppermost, and three were damaged to the point that the pattern was obscured.

Figures 1 - 3 show body shape and life colors of adult males and females. Sexual dimorphism includes more subdued body and fin color patterns and less developed fins in females as compared to males. Neither sex shows a rivulus-spot at any life history stage. The two largest male specimens have one or two spine-like contact organs on the margins of the lateral body scales. Both sexes develop a broad diffuse lateral stripe when stressed or sexually excited (Fig. 3). This stripe runs through the ventral half of the eye and is centered below the body axis. The stripe appears maroon brown in males, dark gray in females.

Life colors. Male: Dark brown to black lips, dark brown extends back to eye. Iris reflective yellow gray, dark gray above pupil, ventral anterior quarter dark gray when stressed. Dark red to brown reticulations over gill cover, two or three gill cover scales with golden centers. Gill covers blue-gray otherwise. Chin and branchiostegal region pearly white. Dorsum of head uniform tan. Belly cream to anal-fin origin. Body sides pink anteriorly, blue gray posteriorly, overlain with a pattern of blood red blotches, dots and reticulations. Dorsum uniform tan. Pectoral-fins hyaline, orange at base. Pelvic-fins orange at base, yellowish distally with powder blue along anterior margin. Anal-fin orange along base, then blue gray, then yellow gray distally with a narrow black anterior and distal margin. Dorsal-fin orange along base, blue gray distally, obscure to well developed reticulated pattern in posterior portion, narrow dark gray anterior and distal margin. Caudal-fin with orange crescent along base, fin rays pale orange, membranes blue gray, central area of fin reticulated in some individuals. Dorsal and ventral elongated rays and membranes blue to yellow, thin dorsal dark margin, thicker distal black margin and intermediate width ventral black margin.

Female: Iris silver gray, chin white, branchiostegal area cream, lips gray brown, extending back to eye, brown reticulations behind eye over gill cover. Dorsum of head mottled gray brown. Body translucent, vertebral column visible, ground color gray tan, white peritoneum visible, scattered red spots and blotches, concentrated from midbody to beginning of caudal peduncle, dorsal scales with dark gray centers. Paired fins

Fig. 4. *Rivulus lyricauda* collection locality DCT 90-7; a typical savanna morichal with rank growth of grass.

hyaline, unpaired fins hyaline to heavily reticulated, distal margin of caudal-fin light to dark gray.

Color in alcohol. Males: Head sharply bicolor, lower lip dark gray brown, two rows of scales behind eye with dark brown margins. Chin and ventral part of head light tan. Dorsum of head and body brown, scale centers a little lighter. Belly and pectoral-fin base light tan. Area dorsal to anal-fin base dusky, caudal peduncle uniform dusky brown, or with lighter scale centers. Pectoral-fin dusky, with or without black markings along distal margin. Pelvic-fins translucent, unpigmented, dusky exterior margins. Dorsal-fin interradial membranes dusky; brown reticulations in distal $^2/_3$ of fin. Anal-fin dusky with dark distal margin. Caudal-fin slate gray at base, lighter distally, dark gray to black ventral and distal margins. Extended rays may be lighter gray.

Females: Head and body as males, but more contrast between scale margins and centers to give reticulated pattern on dorsum and caudal peduncle. Pectoral-fins unpigmented, pelvic-fins unpigmented with or without dusky exterior margin. Dorsal-fin reticulated along base, dark brown interradial membranes distally. Anal-fin with light gray basal stripe, then weak dark brown reticulation, distal half with dusky interradial membranes. Basal $^2/_3$ of caudal-fin with 4 to 6 fan like rows of dark brown reticulations, distal $^1/_3$ with light gray interradial membranes.

Distribution. Known only from the Rio Caroni, probably widespread in the upper basin: known from Arekuna on the Rio Caroni itself, in the vicinity of Canaima on the lower Rio Carrao, and from upper Rio Carrao tributaries on the other (south) side of Auyantepuy.

Etymology. The specific epithet *lyricauda*, a noun in apposition, is derived from Latin *lyrus*, lyre, and *cauda*, tail, and refers to the shape of the caudal-fin. Aquarists have used "lyretail rivulus" as a common name for this species.

Discussion

Three rivulids are presently known from the Rio Caroni basin. We have collected *Rivulus deltaphilus* Seegers, 1983 from several localities in the lower part of the drainage, *R. lyricauda* from the Canaima area as described above, and the third is an undescribed species known from the Gran Sabana in the upper part of the basin. All three are relatively small species that show no sign of annual killifish lifestyle adaptations. An annual rivulid, *Rachovia maculipinnis* (Wiebezahn, 1964) is known from several localities along the southern floodplain of the Orinoco River, both above and below the confluence of the Caroni, but is not known from the Caroni basin proper.

Around Canaima there is a mosaic of savanna and forest, and *R. lyricauda* lives in both habitats. We have found it in both clear and black waters, and all our sites had flowing water present. It seems most abundant in savanna habitats (Fig. 4) where rank growth of grass makes collecting particularly difficult. The area around Canaima has been subject to some human modification, but *R. lyricauda* has persisted for at least 21 years in close proximity to the tourism related activities at Campamiento Canaima.

Males of many species of African aplocheilid killifish develop lyretails, as do males of some annual rivulids, for example: *Austrofundulus limnaeus* Schultz, 1949, *Rachovia brevis* (Regan, 1912), *Pterolebias peruensis* Myers, 1954, and *Terranatos dolichopterus* (Weitzman & Wourms, 1967). Males of most *Rivulus* species have rounded caudal-fins similar to those of females. Males of *Rivulus magdalenae* Eigenmann & Henn, 1916 and *R. rectocaudatus* Fels & de Rahm, 1982 develop truncated caudal-fins, but *R. lyricauda* is the first *Rivulus* species known in which males develop both dorsal and ventral caudal-fin ray extensions to form a full lyretail.

Hoedeman (1959) recognized several species groups within *Rivulus*; based largely on head scale patterns. His "breviceps group" includes small species that usually have an f-scale pattern, often develop a lateral stripe, lack a rivulus-spot in both sexes, and produce relatively large eggs. Several species of this group occur near the Guyana shield. One of us (HOB) has crossed male *R. lyricauda* with females of two "breviceps group" species: *R. agilae* Hoedeman, 1954 from Mont Mahuri, French Guiana (males from this population develop extentions of the lower caudal-fin rays, but not of the upper rays), and *Rivulus*, sp. n. from Amapa, Northwest Brazil (Berkenkamp, in prep.). Eggs were produced by both crosses, but did not develop beyond clevage, and died after nine and eleven days, respectively.

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Erratum

Please note the following corrections for the paper by Jamie E. Thomerson, Heinz O. Berkenkamp and Donald C. Taphorn, '*Rivulus lyricauda*, a new species from the Guyana Shield in Eastern Venezuela (Cyprinodontiformes: Rivulidae)' which appeared in **Ichthyological Exploration of Freshwaters** 1 (4): 289-294.

Due to an editorial error, the catalogue numbers and data of specimens SMF 18436 and 18437 are incorrect. They should be replaced by the following sentence: 'ZSM 27957, 2 females, 30.0-32.6 mm; same data as holotype'.