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Rivulus tecminae, a new killifish from Amazonas Territory, Venezuela (Cyprinodontiformes: Rivulidae)

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Rivulus tecminae, new species, is described from the upper Orinoco basin in Amazonas Territory, Venezuela. Males are iridescent green, with sharply contrasting dark red body stripes. Both sexes have elongated pelvic-fin rays that reach past the anal-fin origin in females and to the 7th to 9th anal-fin ray in males. This species shares a unique imbricated head scale pattern, and retention of a rivulus spot in adults of both sexes, with *R. rectocaudatus*, a Peruvian Amazon species which has short pelvic fins in both sexes.

Se describe *Rivulus tecminae*, de la parte alta de la cuenca del río Orinoco en el Territorio Federal Amazonas de Venezuela, como una especie nueva para la ciencia. Los machos son de un color verde brillante, con franjas rojas horizontales bien definidas en los costados del cuerpo. Ambos sexos de la especia nueva tienen las aletas pelvicas alargadas, extendiendo por detrás del origen de la aleta anal en las hembras, y hasta el radio numero 7 a 9 de la aleta anal en los machos. La especia nueva comparte con *R. rectocaudatus* el patrón de escamas solapadas en el dorso de la cabeza y la 'mancha de rivulus' en los adultos de ambos sexos. En *R. rectocaudatus*, una especie de la cuenca del río Amazonas en Peru, las aletas pelvicas son cortas.

Introduction

For the past three years the company Tecnica Minera, or TECMIN, has been conducting geological and biological surveys in Bolivar State, and in the Venezuelan Federal Territories of Amazonas and Delta Amacuro. The fish faunas of these areas are poorly known in comparison to the rest of Venezuela, so it is fortunate that DCT and LGN have been able to participate in several TECMIN survey expeditions. During 1989, LGN made a total of 116 fish collections from upper Orinoco tributaries in Amazonas Territory. Included were twelve collections from the Rio Sipapo, lower Rio Ventuari, and Rio Atabapo drainages, totaling 156 individuals of an undescribed *Rivulus* species. This new species, described below, shares a unique imbricated head scale pattern and other features with *R. rectocaudatus* Fels & de Rahm, 1981, described from near Iquitos, Peru, in the upper Amazon basin.

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Fig. 1. *Rivulus tecminae*, large male. Field # LN 89-64. Not included in type material.

Methods

Measurements and counts follow Hoedeman (1959), with the exception that head depth (HD) was taken at the posterior margin of the preopercle. Measurements not taken by Hoedeman include prepelvic-fin insertion length (PP2L), snout length (SnL), and orbit diameter (OD). Ratios are expressed in thousandths of standard length (SL) or head length (HL). Measurements were made with Helios dial calipers. Fin ray counts were made under a dissecting microscope, using transmitted light, and include all discernable fin rays. Color descriptions are based on color slides and observation of wild-caught fish in the aquarium. Institutional abbreviations follow Leviton et al. (1985). The MAC-PAY collection is at the Estacion Experimental Amazonas-FONAIAP in Puerto Ayacucho, Venezuela.

Rivulus tecminae, new species

(Figs. 1 - 3)

Holotype. MCNG 23886, male, 37.6 mm, open savanna pools about 500 m from left bank, Rio Guayapo, about 83 km above confluence with Rio Sipapo, Orinoco Basin, Amazonas Federal Territory, Venezuela, 04°16'N 67°20'W, 28 May 1989, L. Nico & E. Guayamare, Field # LN 89-58.

Paratypes. Orinoco Basin: MBUCV 20344, 2 males, 37.6 and 37.4 mm; 2 females, 39.2 and 37.7 mm; FMNH 100599, 2 males, 37.7 and 37.0 mm; 2 females, 33.3 and 31.2 mm; MCNG 21369, 33, 39.7- 11.1 mm; MCNG 23887, female, 38.7 mm SL; all collected with holotype. - MCNG 21363, 9, 36.5-34.2 mm; small forest pools near creek about 1 km E of Rio Guayapo, about 78 km above confluence with Rio Sipapo, 04°15'28"N 67°22'00"W, alt. 160 m, 26 May 1989, L. Nico, Field # LN 89-55. - MCNG 21364, 46, 35.7-12.4 mm; temporary pools in savanna about 200 m SW Rio Guayapo, about 71 km from confluence with Rio Sipapo, 04°15'N 67°23'W, alt. 125 m, 27 May 1990, L. Nico & G. Fuenmayor, Field # LN 89-56. - MCNG 21368, 7, 34.2-18.5 mm, pools in savanna/forest mosaic about 200 m S Rio Guayapo, about 83 km from confluence with Rio Sipapo, 04°16'N 67°20'W, 27 May 1989, L. Nico & G. Fuenmayor, Field # LN 89-57. - MCNG 21372, 20, 38.4-12.4 mm, small creek about 200 m SE Rio Sipapo just below Salto Remo, 04°34'N 67°18'W, alt. about 120 m, 30/31 May, 1989, L. Nico & G. Fuenmayor, Field # LN 89-64. - MCNG 21375, 7, 31.9-27.6 mm, small isolated pools near left bank Rio Sipapo at Salto Remo, 04°34'28"N 67°18'31"W, alt. about 120 m, 1 Jun 1989, L. Nico, Field # LN 89-69. - MCNG 21844, 1, 11.0 mm, flooded grasses along left bank Rio Sipapo about 200 m below Salto Remo, 04°34'N 67°18'W, alt. 115 m, 2 Jun 1989, L. Nico, Field # LN 89-70. -

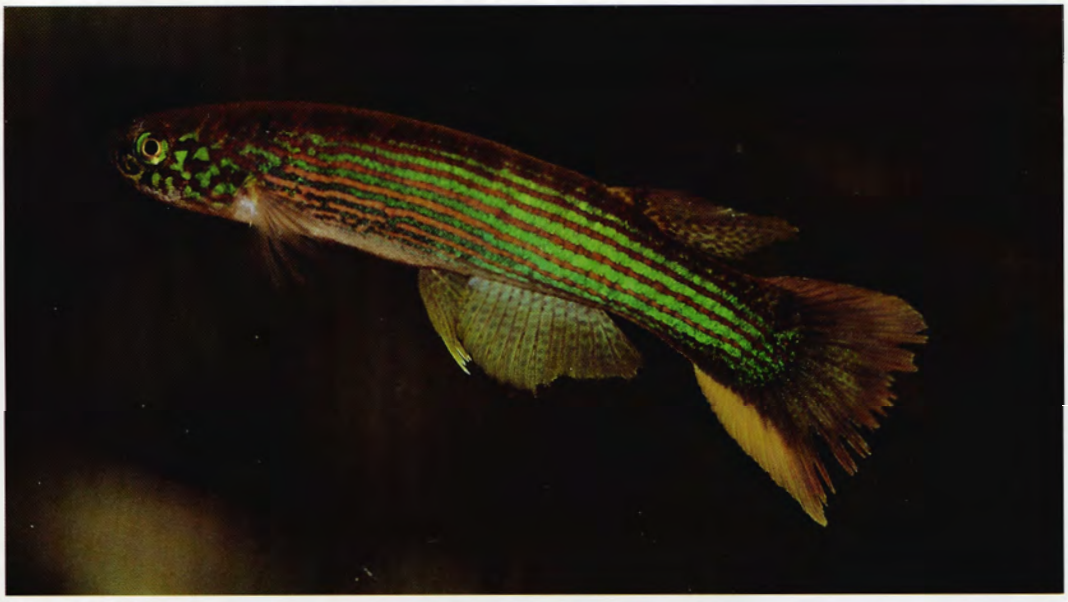

Fig. 2. *Rivulus tecminae*, large male. Field # LN 89-163. Not included in type material.

Fig. 3. *Rivulus tecminae*, two adult females, paratypes, MCNG 21369.

MCNG 23899, 6, 36.4-23.9 mm, open savanna morichal pools about 1 km W Rio Guapuchí, 04°14'N 66°44'W, alt. 80 m, 23 Sept 1989, L. Nico, Field # LN 89-96. - MCNG 23905, 2, 54.9-54.4 mm, forest stream and pools about 2 km from right bank, Caño Cuchakén, about 13 km above confluence with Rio Atabapo, 03°31'N 67°22'W, alt. 80 m, 29 Oct 1989, L. Nico & H. Bolivar, Field # LN 89-138. - MCNG 23907, 1, 29.9 mm, forest stream about 500 m from right bank of Rio Atacavi near indigenous community of Platanillal, 03°09'N 67°09'W, alt. 140 m, 06 Nov 1989, L. Nico & A. Gavelan, Field # LN 89-148. - MCNG 23909, 2, 25.0-22.1 mm, forest pools about 500 m N Caño

Table 1. Morphometric values for five males (including holotype) and five females from the topotypic series of *Rivulus tecminae*.

Character	Holotype	Range	Average	Range	Average
Sex	Male	Males		Females	
SL mm	40.8	37.0 - 40.8	38.1	31.2 - 39.2	36.0
TL/SL	1.221	1.199 -1.253	1.228	1.196 -1.264	1.232
PDL/SL	.706	.706 - .730	.719	.731 - .760	.746
PAL/SL	.588	.588 - .618	.607	.581 - .652	.624
PP2L/SL	.493	.483 - .516	.500	.519 - .556	.563
GBD/SL	.194	.189 - .207	.194	.196 - .222	.210
CPD/SL	.120	.113 - .120	.117	.113 - .120	.118
P1L/SL	.177	.166 - .184	.177	.143 - .172	.160
P2L/SL	.193	.154 - .195	.176	.112 - .126	.119
DL/SL	.277	.277 - .299	.284	.216 - .263	.242
DB/SL	.118	.090 - .118	.104	.095 - .106	.099
AL/SL	.343	.319 - .350	.336	.273 - .305	.285
AB/SL	.169	.166 - .178	.171	.152 - .163	.155
HL/SL	.219	.219 - .251	.233	.236 - .267	.250
HW/HL	.761	.695 - .761	.714	.698 - .766	.730
HD/HL	.631	.592 - .633	.616	.577 - .617	.595
OD/HL	.325	.296 - .325	.308	.293 - .316	.303
SnL/HL	.207	.181 - .226	.207	.144 - .214	.176

Bocachico about 500 m above confluence with Rio Atacavi, 03°10'N 67°21'W, alt. about 130 m, 11 Nov 1989, L. Nico, Field # LN 89-155. - MCNG 23190, 12, 48.1-29.6 mm, isolated savanna pools about 500 m left bank Caño Patacame (also called Caño Cabezón) about 8 km above confluence with Rio Atabapo, 03°18'N 67°21'W, alt. 135 m, 15 Nov 1989, L. Nico, Field # LN 89-163. - MACPAY 1155, 13, 29.0-19.3 mm; Balneario in pond 9 km from San Fernando de Atabapo by road, J. Fernández, A. Orozco, & W. Sanchez.

Diagnosis. *Rivulus tecminae* is distinguished from most other *Rivulus* species by its unique imbricated head squamation (Fig. 4). This pattern is shared with *R. rectocaudatus*. *Rivulus tecminae* differs from *R. rectocaudatus* (and most other *Rivulus* species) in possession of elongated pelvic fins reaching posterior to anal-fin insertion in both sexes (vs. short pelvic fins usually not reaching anal-fin insertion in either sex), predominantly green (vs. yellow to red) male body color, and strongly patterned (vs. unpatterned) caudal fin in females.

Description. Moderately large (largest male 54.9 mm, largest female 48.1 mm SL) sexually dimorphic species. Female caudal fin well developed, rounded; male caudal fin rectangular, or distally expanded with truncate distal margin, or expanded with dorsal, medial, and pelvic-fin rays slightly more elongated than intervening rays. Morphometric data for the holotype and nine paratopotypes are given in Table 1. Males tend to have relatively larger pectoral-fin length, pelvic-fin length (pelvic fin reaches as far as base of 3rd anal-fin ray in females, to base of 7th to 9th anal-fin ray in males, but often damaged), dorsal-fin length, anal-fin length, and anal-fin base length than females; females tend to have relatively longer predorsal length, prepelvic-fin insertion length, and greatest body depth. Females tend to have larger head length, so males tend to have larger head depth/head length and snout length/head length ratios. Number of individuals (out of 10) given in parentheses after each meristic value; value for holotype is underlined: lateral scales 38(3), 40(4), 41(1), 43(2), + 2 to 4 scales on base of caudal fin; transverse scales 9(6), 10(2), 11(2); dorsal-fin rays 8(5), 9(3), 10(2); anal-fin rays 12(2), 13(4), 14(3), 15(1); left pectoral-fin rays 13(1), 14(8), 15(1); left, right pelvic-fin rays 6,6(8), 7,6(1), 7,7(1).

Life colors. Males (Figs. 1-2): Dorsum dark brown. Iris brown with little iridescence; sides of head dark maroon with blue-green spots and short dashes around eye and on gill cover, lower

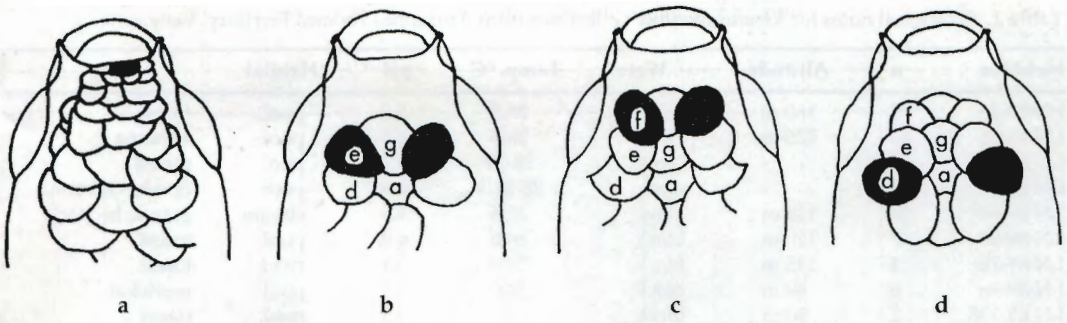

Fig. 4. Head scalation patterns: **a,** imbricated pattern (*Rivulus tecminae*, camera lucida drawing from 37.7 SL male paratype, FMNH 100059); **b,** e-scale pattern (*R. holmiae*, camera lucida drawing from holotype, FMNH 53535); **c,** d-scale pattern; **d,** f-scale pattern (c and d after Hoedeman, 1958, Fig. 1).

lip and chin dark brown, branchiostegal area cream; body sides with seven to nine rows of iridescent green stripes running through scale margins, separated by alternate dark red stripes running through scale centers; faint irregular dorsolateral blotches, belly white, obscure to dark 'rivulus spot' with or without faint ocellation. Dorsal fin grey with rows of faint brown spots in posterior interradial membranes; base of anal fin blue-grey, distally grey with or without yellow tint, obscure rows of brown spots in interradial membranes; caudal fin with olive-green interradial membranes ranging from translucent to almost black, often with ventral light yellow, white, or grey marginal stripe, sometimes a less well developed dorsal marginal stripe, distal margin obscure to grey to dusky yellow; pectoral fins transparent to cloudy grey; pelvic fins translucent grey to yellow-grey, elongated rays white to yellow. Females (Fig. 3): Dorsum reddish brown, with eight to 12 irregular faint vertical bars extending onto body sides. Iris iridescent yellow-brown; gill covers red-brown with faint green spots, lower lip and chin black, branchiostegal area and belly dusky pink, brick-red lateral stripes through scale centers anteriorly changing to rows of separated obscure dots on scale centers posteriorly, separated by grey to brown stripes through scale margins that show some green iridescence along the lower sides and caudal peduncle; large irregular black 'rivulus spot' with or without faint partial ocellation. Dorsal fin transparent, rows of brown interradial spots in proximal part; anal fin with thin basal blue grey stripe, then translucent with rows of small brown interradial spots in basal half, with or without yellow to pink tinge distally; caudal fin transparent, fan-like rows of dark brown interradial spots extending to distal edge; pectoral fins transparent; pelvic fins grey, sometimes with yellow to white tinged extended rays. Juveniles: similar to females, but vertical bars more strongly developed.

Color in alcohol. Males: Very dark. Dorsum uniform dark grey-brown; eye cloudy, lower lip dusky, chin dark grey-brown, branchiostegal area mottled grey-brown to dusky; sharp lateral dark grey-brown stripes through scale margins, intervening stripes through scale centers tan, darker dorsally; belly dark tan anteriorly, dusky posteriorly; 'rivulus spot' dark grey to almost black. Dorsal fin dusky grey-brown with rows of faint brown spots in the posterior interradial membranes; anal fin dusky throughout; caudal fin grey-brown to almost black, lighter grey ventral and dorsal marginal stripes sometimes present; pectoral fins cloudy to dusky grey; pelvic fins dark grey proximally, light brown distally. Females: Dorsum dark brown, 8 to 12 irregular faint vertical bars extending onto body sides. Eye cloudy, gill covers mottled, lower lip dusky, chin dark, branchiostegal area and belly tan, lateral stripes obscure dorsally and on the caudal peduncle; black 'rivulus spot' with faint ocellation. Dorsal fin dusky, rows of brown interradial spots in proximal part; anal fin translucent, obscure rows of small brown interradial spots in basal half; caudal fin translucent, fan-like rows of dark brown interradial spots extending to distal edge; pectoral fins transparent; pelvic fins light tan.

Table 2. Ecological notes for *Rivulus tecminae* collections from Amazonas Federal Territory, Venezuela.

Field No	n	Altitude	Water	Temp. °C	pH	Habitat	Area
LN 89-55	9	160 m	clear	25.5	5.0	pool	forest
LN 89-56	46	125 m	clear	26.5	4.5	pool	savanna
LN 89-57	7	-	clear	28-29	5.2	pool	mixed
LN 89-58	43	-	clear	28-31.5	4.6	pool	flooded savanna
LN 89-64	20	120 m	black	27.5	4.5	stream	granite bedrock
LN 89-69	7	120 m	black	26.0	4.8	pool	forest
LN 89-70	1	115 m	black	25.0	5.1	river	forest
LN 89-96	6	80 m	black	30.0	5.5	pool	morichal
LN 89-138	2	80 m	black	-	5.5	pool	forest
LN 89-148	1	140 m	black	-	-	stream	forest
LN 89-155	2	130 m	black	27.0	4.5	pool	forest
LN 89-163	12	135 m	clear/black	29-32	5.0	pool	savanna

Etymology. *tecminae* is named in recognition of the TECMIN support which made collection of this species possible.

Discussion

Rivulus tecminae were collected (Fig. 5; Table 2) at altitudes of 80 to 160 m, from black water and clear water, 25 to 32°C, pH 4.5 to 5.5, 0 Total Dissolved Solids; and from a wide variety of habitats: isolated savanna pools (Figs. 6 & 7), small savanna streams, tiny isolated forest pools (Fig. 8), small forest streams, and streams draining isolated granitic hills. All collections were made in shallow water, typically less than 20 cm deep. The pool sites were characterized by a layer of decaying leaves and other plant litter covering the pool substrate. Several collections included both large adults and small juveniles, so we doubt that it is an annual species.

Hoedeman (1958, 1959, 1961) attempted to organize the large and morphologically conservative genus *Rivulus* Poey, 1860 into groups or species complexes based mainly on shared possession of head scale patterns in which the paired d, e, or f scales (Fig. 4) occupied the uppermost, completely exposed, position. Hoedeman (1961) recognized 45 species or subspecies of *Rivulus*, but was forced to rely on the literature for characteristics of about three quarters of these forms, because he had only 14 nominal *Rivulus* species (*breviceps* ?, *frenatus* ?, *manaensis, agilae, geayi, waimacui* ?, *marmoratus, urophthalmus, stagnatus* ?, *lanceolatus* ?, *cylindraceus, micropus* ?, *harti* and *holmiae* ?) at hand. The first author has had the opportunity to reexamine most of the material studied by Hoedeman. The question mark (?) after the species epithet indicates that, for one of several reasons, we question Hoedeman's identification of his material. For example, Hoedeman characterized the *R. breviceps* group as having an f-scale pattern. However, JET has recently examined type material of *R. breviceps* Eigenmann, 1909 (FMNH 52710, the holotype, and CAS 44211, 3 paratypes). The holotype has a central g-pattern head squamation; of the paratypes, two

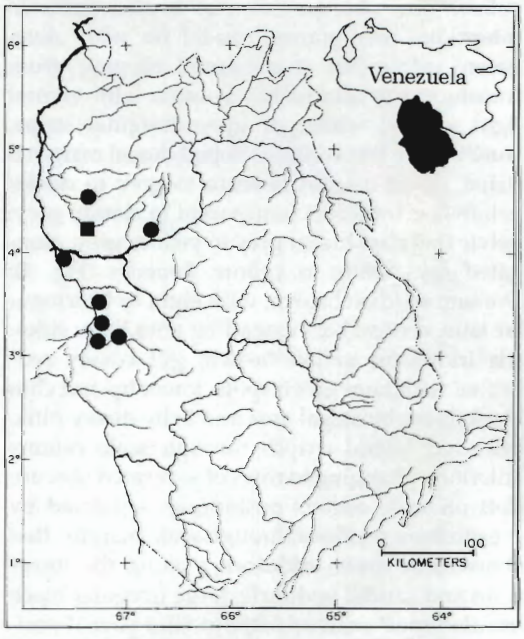

Fig. 5. Distribution of *Rivulus tecminae* in Amazonas Federal Territory, Venezuela. Each dot may represent more than one near-by locality. The square indicates the type locality.

Fig. 6. Type locality of *Rivulus tecminae*; open savanna pools near the Rio Guayapo.

Fig. 7. Savanna pool with *Rivulus tecminae*, near Caño Patacame, Rio Atabapo basin, LN 89-163.

Fig. 8. Forest pool with *Rivulus tecminae*, near Caño Bocachico, Rio Atacavi-Atabapo basin, LN 89-155.

have well preserved e-pattern but the third is damaged beyond recognition. Thus the type series of the 'typical' species of the *breviceps* group does not show the f-scale pattern Hoedeman used to define the group.

Also there are problems with: variation such that an individual might have an exposed e scale on one side and an exposed d scale on the other (attributed to hybridization between various species groups by Hoedeman, but see Seegers, 1983); ease with which the head scalation of many species can be damaged beyond recognition during capture or preservation; individuals and species (Miller & Hubbs, 1974) which have no organized pattern; and discovery of new patterns such as the 'imbricated' pattern (Fig. 4), first reported by Fels & de Rahm (1982: 100) in *R. rectocaudatus*, whose only completely exposed head scale is a small scale just posterior to the upper lip. From this scale back, on either side of the midline, the scales are imbricated (overlapped like shingles) with the rear margins exposed, similar to the body scale pattern. Keeping in mind the problems listed above, we hypothesize an informal '*rectocaudatus* species group', to include *R. rectocaudatus*, and *R. tecminae*. The major group character, presumably a synapomorphy, is the imbricated head squamation; others include moderate size, sexual dimorphism, striped male body pattern, 'rivulus spot' often present in both sexes, and male caudal fins with truncate to three-angled distal margins.

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