A new killifish genus and species from the coastal plains of northeastern Brazil (Teleostei: Cyprinodontiformes: Rivulidae)

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Abstract

Prorivulus auriferus, new genus and species, from the coastal plains of northeastern Brazil, is described. It is a member of a monophyletic unit, including Rivulus and the clade comprising all annual fish rivulid genera, diagnosed by two unambiguous synapomorphies: unossified interhyal and distal process of the second epibranchial absent. Prorivulus is hypothesized to be the sister group of the monophyletic assemblage including Rivulus and the clade comprising all annual fish rivulid genera, which is defined by four unambiguous synapomorphies: shortened uncinate process of the third epibranchial, articular face of the distal edge of first hypobranchial anteriorly expanded, ventral process of angulo-articular narrowed, and posterior flange of cleithrum absent. Prorivulus is distinguished from other basal rivulid taxa by having five branchiostegal rays.

Key words: Killifish, Cyprinodontiformes, Rivulidae, Neotropica, systematics, taxonomy, new genus, new species

Resumo

Prorivulus auriferus, novo gênero e espécie, das baixadas costeiras do nordeste do Brasil, é descrita. Ela é um membro de uma unidade monofilética incluindo Rivulus e o clado compreendendo todos os gêneros rivulídeos de peixes anuais, diagnosticado por duas sinapomorfias não ambíguas: interial não ossificado e processo distal do segundo epibranchial ausente. Prorivulus é hipotetizado ser o grupo irmão do agrupamento monofilético incluindo Rivulus e o clado compreendendo todos os gêneros rivulídeos de peixes anuais, que é definido por quatro sinapomorfias não ambíguas: processo uncinado do terceiro epibranchial encurtado, face articular da margem distal do primeiro hipobranchial expandida anteriormente, processo ventral de angulo-articular estreito, e aba posterior de cleitro ausente. Prorivulus se distingue de outros táxons de rivulídeos basais por possuir cinco raios branquiostegais.
Introduction


Parenti (1981) first proposed *Rivulus* to be a paraphyletic assemblage. Monophyly of a group containing the great majority of species traditionally placed in *Rivulus*, including its type species (*R. cylindraceus* Poey), and all annual fish rivulid genera is strongly supported (Costa, 2004a). However, this clade does not comprise some species previously placed in *Rivulus*, now placed in *Kryptolebias*: *K. brasiliensis* (Valenciennes), *K. marmoratus* Poey, *K. ocellatus* Hensel, and *K. caudomarginatus* Seegers, which form a basal rivulid monophyletic assemblage, constituting the sister group of the remaining rivulids (Costa, 2004a).

A new non-annual *Rivulus*-like rivulid taxon, having some primitive rivulid traits also occurring in *Kryptolebias*, but sharing some apomorphic conditions with *Rivulus* and all annual rivulid fish genera, was recently collected in a coastal plain area of northeastern Brazil. It is herein described as a new genus and species.

Material and methods

Measurements and counts follow Costa (1995). Measurements are presented as percentages of standard length (SL), except for those relative to head morphology, 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 & Van Dyke (1985). Terminology for frontal squamation follows Hoedeman (1958) and for cephalic neuromast series follows...

**Prorivulus** new genus

**Type species:** *Prorivulus auriferus* Costa, Lima & Suzart, new species.

**Diagnosis:** A non-annual fish genus, similar to *Rivulus* and *Kryptolebias*, and distinguished from the remaining rivulid genera by having anal-fin rays soft in both sexes (vs. hardened in females), urogenital papilla minute in males (vs. prominent and tubular), and absence of a dark bar on iris (vs. presence). Similar to *Kryptolebias* and distinguished from *Rivulus* by possessing frontal E-scales overlapped (vs. not overlapped), third epibranchial with distinct uncinate process (vs. short indistinct process), distal cartilage of the first hypobranchial restricted to articulation with first ceratobranchial (vs. cartilage expanded anteriorly), ventral process of angulo-articular broad (vs. narrow), and posterior flange of cleithrum absent (vs. present). Similar to *Rivulus* and distinguished from *Kryptolebias* by having unossified interhyal (vs. ossified) and by the absence of the distal process of second epibranchial (vs. presence). Differs from other rivulids, except the two species of *Stenolebias* and *Rivulus romeri* Costa, by having five branchiostegal rays (vs. six).

**Included taxa:** Only the type species.

**Etymology:** From the Latin *pro* (a prefix meaning priority in space or time) and *rivulus* (stream, and also a nominal rivulid genus), referring to the basal position of the genus regarding *Rivulus* and all the annual fish rivulid genera. Gender masculine.

**Prorivulus auriferus** Costa, Lima & Suzart, new species

(Figs. 1–2)

**Holotype.** UFRJ 5932, male, 30.3 mm SL; Brazil: Estado da Bahia: Valença, coastal stream (24L 0503477 UTM 8505050); A. O. Lima & R. R. Suzart, 28 June 2003.

**Paratypes.** UFRJ 5933, 1 female, 22.9 mm SL, and 3 juveniles, 13.1–15.5 mm SL; UFRJ 5934, 1 male, 28.5 mm SL, and 2 juveniles, 17.0–18.3 mm SL (c&s); collected with holotype.

**Diagnosis:** As for the genus.

**Description:** Morphometric data given in Table 1. Male larger than female, largest male 30.3 mm SL. Dorsal profile slightly convex from snout to end of dorsal-fin base, approximately straight on caudal peduncle. Ventral profile convex on head, almost straight from anterior portion of venter to end of anal-fin base, nearly straight to slightly concave
on caudal peduncle. Body slender, subcylindrical anteriorly, slightly deeper than wide, to compressed posteriorly. Greatest body depth at level of pelvic-fin base.

**FIGURE 1.** *Prorivulus auriferus*, UFRJ 5932, male, holotype, 30.3 mm SL (two weeks after collection); Brazil: Bahia: Valença.

**FIGURE 2.** *Prorivulus auriferus*, UFRJ 5933, female, paratype, 22.9 mm SL (two weeks after collection); Brazil: Bahia: Valença.


Scales large, cycloid. Body and head entirely scaled, except anterior ventral surface of head. Few scales on caudal-fin base; no scales on dorsal and anal fins. Frontal squamation E-patterned; E-scales overlapping medially; scales arranged in circular pattern around central A-scale without exposed margins. Longitudinal series of scales 31–33; transverse
series of scales 8; scale rows around caudal peduncle 16. Contact organs absent. Supraorbital neuromasts 3 + 3.


TABLE 1. Morphometric data of Prorivulus auriferus sp. n..

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<th>males holotype</th>
<th>male paratype</th>
<th>female paratype</th>
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<td>UFRJ 5934</td>
<td>UFRJ 5933</td>
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<td>Eye diameter</td>
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**Coloration in life:** Male: Side of body light gray with irregular shaped golden blotches below lateral midline, and zigzag dark purplish gray stripe on lateral midline overlapped by oblique bars of same color scattered over flank. Dorsum light yellowish brown, venter light yellow. Postorbital pale brown, golden on ventral portion of opercle.


**Distribution:** Known only from the type locality, a coastal plain brook in the Município de Valença, northeastern Brazil.

**Habitat notes:** The type series was collected in a shallow (about 40 cm deep), small freshwater brook within a forest, near a salt water canal. It is situated in a coastal region, with a net of canals forming a series of small islands. The water was reddish brown, acid (pH 4.0), not turbid. The only other fish species found was the characid *Hyphessobrycon cf. itaparicensis* Lima & Costa.

**Etymology:** From the Latin *auriferus* (auriferous), referring to the male color pattern consisting of golden spots on the flank.

**Discussion**

Five synapomorphies listed by Costa (2004a) for the group including *Rivulus* and the clade comprising all annual rivulids, are not present in *P. auriferus*: E-scales not overlapped (Fig. 3A; reversed in the clade comprising *Simpsonichthys*, *Cynolebias*, *Megalebias*, *Austrolebias*), shortened uncinate process of the third epibranchial (Fig. 4D; unambiguous), articular face of the distal edge of the first hypobranchial anteriorly expanded (Fig. 4F; unambiguous), ventral process of the angulo-articular narrowed (Fig. 4H; unambiguous), and posterior flange of the cleithrum absent (Fig. 4J; unambiguous). These synapomorphies support the monophyly of the group comprising *Rivulus* and the annual fish clade (Fig. 5). *Prorivulus auriferus* present the plesiomorphic conditions for these characters, as occurring in *Kryptolebias* and in aplocheiloids non-rivulids (i.e., nothobranchids and aplocheilids): E-scales overlapped (Fig. 3B), uncinate process of the third epibranchial long (Fig. 4C), articular face of the distal edge of the first hypobranchial not anteriorly expanded (Fig. 4E), ventral process of the angulo-articular broad (Fig. 4G), and posterior flange of the cleithrum present (Fig. 4I).

Two synapomorphies listed by Costa (2004a) support monophyly of the group comprising *Prorivulus*, *Rivulus* and the annual fish clade (Fig. 5): unossified interhyal (unambiguous) and absence of the distal process of the second epibranchial (Fig. 4B;
unambiguous). In *Kryptolebias* and in aplocheiloids non-rivulids the interhyal is ossified and there is a conspicuous distal process on the second epibranchial (Fig. 4A).

**FIGURE 3.** Diagrammatic representation of the frontal squamation in: A, *Rivulus* and most annual fish genera, B, *Prorivulus* and *Kryptolebias*.

The presence of five branchiostegal rays in *Prorivulus* is interpreted as autapomorphic. Other aplocheiloids have six branchiostegal rays, except the cynolebiatine *M. wolterstorffi* (Ahl) with eight rays, the Plesiolebiatini genus *Stenolebias* and *Rivulus romeri* also with five rays (Costa, 1998, 2003b). *Stenolebias* is an annual fish genus, member of the Plesiolebiatini clade, which includes other genera with six rays (Costa, 1998), and *R. romeri* is a member of the *Rivulus atratus* species group, which also includes several species with 6 rays (Costa, 2004b). Therefore, reduction to five branchiostegal rays is considered a homoplastic condition, occurring in three distinct rivulid lineages.

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FIGURE 4. Osteological features of some rivulids: left second epibranchial, ventrosagittal view: A, in *Kryptolebias* (sketch based on *K. brasiliensis*), B, in *Prorivulus, Rivulus* and all the annual rivulid genera (sketch based on *Rivulus janeiroensis*); left third epibranchial, ventrosagittal view: C, in *Kryptolebias* and *Prorivulus* (sketch based on *K. brasiliensis*), D, in *Rivulus* and all the annual rivulid genera (sketch based on *Rivulus janeiroensis*); left first hypobranchial, dorsal view: E, in *Kryptolebias* and *Prorivulus* (sketch based on *K. brasiliensis*), F, in *Rivulus* and all the annual rivulid genera (sketch based on *Rivulus janeiroensis*); left lower jaw, lateral view: G, in *Kryptolebias* and *Prorivulus* (sketch based on *K. brasiliensis*), H, in *Rivulus* and all the annual rivulid genera (sketch based on *Cynolebias griseus* Costa, Lacerda & Brasil); dorsal portion of left shoulder girdle, lateral view: I, in *Kryptolebias* and *Prorivulus* (sketch based on *K. brasiliensis*), J, in *Rivulus* and all the annual rivulid genera (sketch based on *Trigonectes balzanii* (Perugia)).
FIGURE 5. Phylogenetic relationships of basal rivulid lineages, according to synapomorphies established in Costa (2004a): clade A: unossified interhyal, absence of the distal process of the second epibranchial; clade B: E-scales not overlapped, shortened uncinate process of the third epibranchial, articular face of the distal edge of the first hypobranchial anteriorly expanded, ventral process of the angulo-articular narrowed, posterior flange of the cleithrum absent.

References


