**Rivulus berovidesi**, a new killifish species (Teleostei: Rivulidae) from western Cuba

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Abstract

*Rivulus berovidesi*, a new killifish species, is described from a small stream in Sierra de Cajalbana, northwestern Cuba. It is readily distinguished from *Rivulus cylindraceus* Poey by the combination of an exclusive color pattern and meristic characters such as a d-type frontal scalation pattern (versus e-type pattern in *Rivulus cylindraceus*). The current diagnosis of *Rivulus berovidesi* based on chromatic, morphological and meristic characters is consistent with a recent molecular analysis of this genus in Cuba.

Key words: *Rivulus berovidesi*, frontal scalation pattern, killifish, meristic characters

Introduction

The killifish genus *Rivulus* Poey, is the most speciose genus of the family Rivulidae including more than 125 valid species occurring in a great diversity of wetlands (Bussing 2002; Costa 2004, 2005; Valdesalici & Schindler 2011). However, based on recent molecular phylogenies, other authors consider that the genus *Rivulus* (*sensu stricto*) comprises less than five valid species (Hrbek et al. 2004; Costa 2011; Eschmeyer 2014). This group is represented by small oviparous fish (about 20-120 mm standard length) with sexual dimorphism characterized, in most cases, by the presence of an ocellated spot on the caudal fin of females (Ghedotti & Wiley 2002).

The geographic distribution of these fishes covers Middle and South America, where it ranges from Mexico to Argentina, although there are some species inhabiting many Caribbean islands (Lasso-Alcala et al. 2006). Particularly, a recent survey concerning the phylogeography of Cuban *Rivulus* (Ponce de Leon et al. 2014) concluded that only one of the two species previously described in this genus (*Rivulus cylindraceus* Poey (1860), the type species) inhabited the whole archipelago. However this same work provided solid evidence on the existence of a different lineage of *Rivulus* in northwestern Cuba, which constitutes the new species herein described.

During recent field trips to the mountain system Sierra de Cajalbana, located in northwestern Cuba, several specimens of this putative new species were observed and collected. In this paper chromatic, meristic and morphological characters are analyzed to describe this new killifish species.

Material and methods

A total of 23 specimens (11 males and 12 females) of *Rivulus berovidesi* sp. n. were collected at Sierra de Cajalbana, Pinar del Rio province, Cuba (Fig. 1). Measurements and counts were made according to Hoedeman (1959) using a digital caliper (nearest 0.1 mm), under a dissecting microscope. Seven meristic and eight morphometric variables commonly used in descriptions and revisions of killifish species (Hoedeman 1959; Costa 2004; Rodriguez 2009; Valdesalici et al. 2011; Valdesalici & Schindler 2011) were measured. The frontal scalation pattern is described following Hoedeman (1958). All measurements are presented as percentages...
of standard length (SL), except for eye diameter and snout length, which are given as percentage of head length (HL). Body color patterns for both sexes were also documented.

Institutional abbreviations used: CZACC, Instituto de Ecologia y Sistematica, Cuba; MFP, Museo Felipe Poey, Universidad de La Habana, Cuba; MNHN CU, Museo Nacional de Historia Natural, Cuba; MCZ, Museum of Comparative Zoology, Harvard University, USA.

**FIGURE 1.** Distribution map of *Rivulus* species from Cuba. Red spots represent distribution of *Rivulus cylindraceus* and red triangles represents distribution of *Rivulus berovidesi* sp. n., 1 Sierra de Cajalbana (type locality); 2 Rio Camarones.

**Rivulus berovidesi**, new species
(Figs. 2–6)


**Paratypes.** All from Sierra de Cajalbana, Pinar del Rio province, Cuba. Same date and collector as holotype. CZACC-9.84, three males, 31.1–34.7 mm SL; CZACC-9.85, three females, 36.3–37.9 mm SL; MFP18.00570, two males 32.2–32.8 mm SL and two females 33.7–34.3 mm SL; MNHN 1457 one male 31.3 mm SL and two females 31–35.6 mm SL; MZC 171656 and 171657 two males 32.7–37.9 mm SL respectively and MZC 171658 and 171659 two females 31.4–33.5 mm SL respectively.

**Diagnosis.** Both males and females of *Rivulus berovidesi* sp.n. are readily distinguished from *Rivulus cylindraceus* by the presence of a dark lateral band situated longitudinally along the lateral line, extended from the posterior margin of the eye to the base of the caudal fin (versus a lack of this dark lateral band in *Rivulus cylindraceus*). Dorsal fin slightly shifted to the caudal peduncle in relation to the origin of anal fin (1–3 mm) when compared to *Rivulus cylindraceus*. Frontal scalation pattern in *Rivulus berovidesi* sp. n. is d-type versus e-type pattern in *Rivulus cylindraceus* (Fig. 2).

**Description.** Morphometric and meristic data for holotype and 22 paratypes are presented in Tables 1 and 2. Largest examined male 37.9 mm SL; largest examined female 38.0 mm SL. Body subcylindrical anteriorly and compressed posteriorly. Dorsal profile slightly convex from the snout to the posterior base of dorsal fin. Ventral profile slightly convex from the lower jaw to the anal fin origin. Both paired and impaired fins rounded and without filaments. Dorsal fin origin above base of the 5th or 6th anal fin ray. Pectoral fins inserted behind the posterior margin of opercles. Pelvic fins are the smallest, reaching anus. Dorsal fin rays 6–9, caudal fin rays 15–19, anal fin rays 8–11, pelvic fin rays 4–6 and pectoral fin rays 11–14.

Body and head entirely scaled with cycloid scales. Longitudinal series of scales 34–37, transverse series of scales 9, pre-dorsal scales 21–25. Frontal scalation is d-type pattern. Males of *Rivulus berovidesi* sp.n. are yellow and orange ventrally, whereas females are less colored. Figure 3 shows sexual dimorphism in this species, which includes differences in color of body and fins as well as females characterized by a distinctive ocellated caudal spot. Females have a diffuse ocellated caudal spot which can extend from the posterior base of the dorsal fin to the upper margin of the caudal fin.
TABLE 1. Morphometric data for holotype and paratypes of *Rivulus berovidesi* sp. n. Standard length (SL) and head length (HL) are expressed in millimeters; all other measurements are expressed as percentage of SL except for eye diameter and snout length, which are given as percentage of HL.

<table>
<thead>
<tr>
<th>Morphometric variables</th>
<th>Holotype</th>
<th>N</th>
<th>Paratypes</th>
<th>Mean</th>
<th>Min</th>
<th>Max</th>
<th>SD</th>
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<tr>
<td>Standard length (mm)</td>
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<td>23</td>
<td>33.8</td>
<td>28.9</td>
<td>37.9</td>
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<td>Pre-dorsal length</td>
<td>68.0</td>
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<td>70.1</td>
<td>67.3</td>
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<td>Pre-anal length</td>
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<td>59.5</td>
<td>65.3</td>
<td>1.2</td>
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<td>Interdorsal-anal length</td>
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<td>23</td>
<td>8.2</td>
<td>6.8</td>
<td>10.6</td>
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<td>Caudal peduncle depth</td>
<td>13.7</td>
<td>23</td>
<td>12.7</td>
<td>11.1</td>
<td>14.4</td>
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<td>Head length (mm)</td>
<td>10.4</td>
<td>23</td>
<td>9.0</td>
<td>8.1</td>
<td>10.4</td>
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<td>Snout length</td>
<td>28.1</td>
<td>23</td>
<td>30.1</td>
<td>25.9</td>
<td>33.5</td>
<td>2.0</td>
<td></td>
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<tr>
<td>Eye diameter</td>
<td>23.7</td>
<td>23</td>
<td>26.6</td>
<td>23.7</td>
<td>30.0</td>
<td>2.0</td>
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TABLE 2. Meristic data for holotype and paratypes of *Rivulus berovidesi* sp. n. Values in parentheses indicate number of specimens examined with that count.

<table>
<thead>
<tr>
<th>Counts</th>
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<th>Paratypes (N=23)</th>
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<tbody>
<tr>
<td>Pre-dorsal scales</td>
<td>23</td>
<td>21 (4)</td>
</tr>
<tr>
<td>Lateral scales</td>
<td>37</td>
<td>34 (4)</td>
</tr>
<tr>
<td>Dorsal rays</td>
<td>7</td>
<td>6 (4)</td>
</tr>
<tr>
<td>Caudal rays</td>
<td>19</td>
<td>15 (1)</td>
</tr>
<tr>
<td>Anal rays</td>
<td>10</td>
<td>8 (2)</td>
</tr>
<tr>
<td>Pelvic rays</td>
<td>5</td>
<td>4 (4)</td>
</tr>
<tr>
<td>Pectoral rays</td>
<td>11</td>
<td>11 (10)</td>
</tr>
</tbody>
</table>

FIGURE 2. Outline drawings of the frontal scolation patterns of *Rivulus* from Cuba. A: *Rivulus berovidesi* sp. n. with a d-type pattern and B: *Rivulus cylindraceus* with an e-type pattern. The horizontal broken line indicates the pair of scales with their margins fully exposed.
FIGURE 3. *Rivulus berovidesi* sp. n., life coloration in both sexes in specimens kept in captivity for three months after collection in the field.

FIGURE 4. *Rivulus berovidesi* sp. n., life coloration in males (above) and females (below) in specimens just after collection in the field.
FIGURE 5. Rivulus berovidesi sp. n., paratype, female, CZACC-9.85, 37.2 mm SL, small stream in Sierra de Cajalbana, Pinar del Rio province, Cuba.

FIGURE 6. Rivulus berovidesi sp. n., holotype, male, CZACC-9.83, 37.3 mm SL, small stream in Sierra de Cajalbana, Pinar del Rio province, Cuba.
Color in life. Males (Fig. 4): Body coloration is greenish or olive-green dorsally. There is a wide dark lateral band extended from the posterior margin of the eye to the base of the caudal fin. Ventral ground coloration is yellowish with orange spots reaching the anal fin base. An iridescent blue spot is present behind the margin of opercle in both sexes. Males have an iridescent olive-green spot on the opercle too. Dorsal fin is greenish, caudal fin is slightly greenish on its base and more transparent to the edges. Anal fin is spotted in orange in their base and yellow or yellow-green to the ends. Pelvic fins are yellow and pectoral fins are transparent.

Females (Fig. 4): Body coloration less striking when compared to males. General body coloration brown, darker dorsally than ventrally. Ventral coloration is paler with some small yellowish spots. There is a narrow dark lateral band extended from the posterior margin of the eye to the base of the caudal. Diffuse ocellated caudal spot present which can extends from the posterior base of dorsal fin to the superior margin of caudal fin and sometimes along the caudal fin base too (Fig. 4 and 5). All fins slightly greenish or transparent.

Color in preserved specimens. Preserved specimens with the typical dark lateral band from the posterior margin of the eye to the base of caudal fin in both sexes, although slightly paler than living specimens. Ventral region of the body with a yellowish homogeneous coloration while dorsal region is brownish-gray. Males with a reticulated pattern on scales above lateral dark band (Fig. 6) while females with the diffuse ocellated caudal spot extended from the end of dorsal fin to the superior margin of caudal fin (Fig. 5). All fins with a whitish coloration.

Etymology. The specific name of this new species is given in honor to the Professor Vicente Berovides Alvarez, professor at the Faculty of Biology, Universidad de la Habana, Cuba in recognition of his life-long dedication and contribution to train several generations of new researchers in biological sciences.

Distribution and habitat. Rivulus berovidesi sp. n. is known only from northwest mountain system in Pinar del Rio province. Particularly, in Sierra de Cajalbana (type locality) and Rio Camarones. Both localities are situated in northwestern Cuba (Fig. 1). This species inhabits small mountain streams with a depth of 30–70 cm approximately and bottom substrate basically composed by stones, sand and dead leaves (Fig. 7). There is not aquatic vegetation in the area. The streams are clear with pH 7.5 and water temperature 24°C. Other freshwater fish collected together with Rivulus berovidesi sp. n. were: Gambusia punctata, Girardinus uninotatus, Girardinus creolus, Girardinus microdactylus, Nandopsis tetracanthus, Agonostomus monticola and Gobiomorus dormitor.

FIGURE 7. Type locality of Rivulus berovidesi sp. n. Small stream at Sierra de Cajalbana, Pinar del Rio province, Cuba
Discussion

Diagnosis based on morphological and meristic characters of Rivulus berovidesi sp. n. is consistent with the results derived from a recent molecular analysis on the phylogeography of Cuban Rivulus (Ponce de Leon et al. 2014). These authors found that the new species showed 15% cytb and 2.5% CAM-4 sequence divergence with the species R. cylindraceus, which is more than three times the minimum divergence observed between cytb sequences of rivulid sister species (April et al. 2011). Additionally, the apparent non-overlapping geographic distribution of Rivulus cylindraceus and Rivulus berovidesi sp. n. corresponds with the separate phylogeographic history of both species.

Hoedeman (1958), described a d-type pattern for the frontal scalation in Rivulus cylindraceus. However, the current work describes a same pattern in Rivulus berovidesi sp. n. versus a frontal scalation e-type pattern in Rivulus cylindraceus. In our study, frontal scalation pattern of Rivulus berovidesi is compared with the holotype of R. cylindraceus (MCZ 6423) and other specimens collected from well determined populations of this species living in Cuba. Following the examination of frontal scalation carried out in this study and analyzing Hoedeman’s work, where collection locality given is imprecise, it is probable that the specimens examined by this author were collected within the distribution range of Rivulus berovidesi sp. n. and thus belonged to this latter species.

Rivulus berovidesi sp. n. is the first species of Rivulus described from the Cuban archipelago after Rivulus insulaepinorum (now a synonym of Rivulus cylindraceus; Ponce de Leon et al. 2014). As occurs in some other Cuban freshwater fish groups, the diversity of rivulids from Cuba is currently underestimated. This constitutes a potential research subject for its importance in the overall biogeographical landscape and may have significant impact on the knowledge of freshwater fish from the Caribbean. In addition, ecological studies need to be carried out to know life-history details of this new species as well as to assess the conservation status of their populations.

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References


