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A new miniature killifish of the genus *Melanorivulus* (Cyprinodontiformes: Rivulidae) from the coastal plains of north-eastern Brazil

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Abstract

Melanorivulus atlanticus, new species, is described on the basis of specimens collected in the coastal plains of north-eastern Brazil, constituting the first record of the genus for the Atlantic Forest biogeographical province. The new species together *M. decoratus* and *M. jalapensis* form a clade of small species, not surpassing 20 mm SL, mainly diagnosed by the presence of five branchiostegal rays. *Melanorivulus atlanticus* differs from those two species by a narrow black border along the entire caudal fin in males and the presence of 2+1 neuromasts in the mandibular series, besides differing from all congeners by having sexually dimorphic pelvic fin, which is pointed and with seven rays in males, elliptical and with five rays in females. The description of *M. atlanticus* expands in 670 km to east the known geographic range of the genus.

Key words

Atlantic Forest, Biodiversity, Killifish, Systematics, Taxonomy.

Introduction

The genus *Melanorivulus* Costa, 2006 comprises a diversified clade of South American small killifishes inhabiting the main river basins east of the Andes (Costa, 2011). Prior to 2011, all included species were placed in *Rivulus* Poey, 1860, then considered a broad generic unit with weak or no morphological support (*e.g.*, Parenti, 1981; Costa, 1998, 2006a). After 1999, some molecular studies (*e.g.*, Hrbek & Collier, 1999; Murphy *et al.*, 1999) have congruently indicated that *Rivulus* in the broad sense was paraphyletic, with most lineages more closely related to other genera than to *Rivulus cylindraceus* Poey, 1860, the type species of the genus. On the other hand, some intrageneric assemblages supported both by morphology and DNA sequences were proposed as subgenera, including *Melanorivulus* among others (*e.g.*, Costa, 2006a). More recent studies have found morphological evidence corroborating molecular hypotheses (Costa, 2011), reinforcing a phylogenetic context in which most *Rivulus*-like species were more closely related to other genera than to *R. cylindraceus*, a member of a lineage confined to the Greater Antilles. As a consequence, the traditional classificatory scheme with numerous species constituting a paraphyletic genus *Rivulus* has been substituted by a new generic classification, in which the former subgenera are elevated to well corroborated monophyletic genera (Costa, 2011).

Species of *Melanorivulus* are usually found in shallow aquatic habitats, often less than 20 cm deep, situated in marginal areas of streams (*e.g.*, Costa, 2005, 2006b). Recent intensive field studies directed to these habitats have revealed an astonishing diversity of undescribed species, placing *Melanorivulus* among the most

species-rich and geographically widespread genera of aplocheiloid killifishes (Costa, 2003a–b, 2005, 2006b, 2007a–c, 2008 a–d, 2009, 2010, 2012a–b, 2013; Costa & Brasil, 2008; Costa & De Luca, 2011; Costa *et al.*, 2014). Despite the broad area occupied by the genus, the great majority of species are found in savannah regions, whereas a few ones are found in transitional areas between the Cerrado savannah and the Amazon Forest. The new species herein described is the first member of the genus found in an area within the Biogeographical Province of the Atlantic Forest, consisting in a considerable enlargement of the generic geographical distribution.

Material and methods

Material is deposited in UFRJ, Instituto de Biologia, Universidade Federal do Rio de Janeiro, Rio de Janeiro. Specimens were fixed in formalin just after collection, for a period of ten days, and then transferred to 70 % ethanol. Descriptions of colour patterns were based on photographs of both sides of live individuals of each population taken in small aquaria one day after collection; colour patterns derived from distribution of melanophores on fins were also observed in all preserved specimens. Measurements and counts follow Costa (1988). Measurements are presented as percentages of standard length (SL), except for those related to head morphology, which are expressed as percentages of head length. Fin-ray counts include all elements. Number of vertebrae and gill-rakers were recorded only from the cleared and stained specimen; the compound caudal centrum was counted as a single element. The osteological preparation was made according to Taylor & Van Dyke (1985); the abbreviation c&s means specimens cleared and stained for bone and cartilage. Terminology for cephalic neuromast series follows Costa (2001) and for cephalic squamation patterns, Hoedeman (1958).

Melanorivulus atlanticus spec. nov.

Fig 1, Table 1

Holotype: UFRJ 10243, male, 17.3 mm SL; Brazil: Estado de Sergipe: Município de Pirambu: swamp in the coastal Restinga, between Lagoa Grande and Pau Seco, about 3.5 km from the sea coast, 10°37'10"S 36°43'50"W; P.H.N. Bragança & F.P. Ottoni, 23 March 2014.

Paratypes: UFRJ 10244, 4 males, 15.8–17.8 mm SL, 4 females, 13.1–14.9 mm SL; UFRJ 10245, 1 male, 17.8 mm SL, 3 females, 13.4–15.7 mm SL; collected with holotype.

Diagnosis. *Melanorivulus atlanticus* is distinguished from all other congeners, except *M. decoratus* and *M. jalapensis*, by having five branchiostegal rays (*vs.* six); it is also similar to *M. decoratus* and *M. jalapensis* by having a narrow basihyal, its width about 35 % of the longitudinal length, a condition also occurring in *M. paresi*, thus contrasting with the wider basihyal, with 45–60 % of that length, in all other congeners. It is distinguished from *M. decoratus*, *M. jalapensis* and all other species of the genus by having sexually dimorphic pelvic fin, pointed and with seven rays in males, elliptical and with five rays in females (*vs.* never sexual dimorphism in pelvic-fin shape, always seven pelvic-fin rays in both sexes). Also distinguished from *M. decoratus* and *M. jalapensis* by having a narrow black border along the entire caudal fin in males (*vs.* a broad dark grey stripe on the ventral margin of the caudal fin in *M. decoratus* and no distinctive colour on caudal fin margin border in *M. jalapensis*) and 2+1 neuromasts in the mandibular series (*vs.* 3+1). Similar to *M. decoratus* by having irregularly arranged, vertically elongated black spots on the caudal fin in females (*vs.* caudal fin dark reddish grey with white short bars and spots in *M. jalapensis*). Also distinguished from *M. decoratus* by the presence of oblique red bars restricted to the basal and posterior portions of the anal fin in males (*vs.* bars extending through most fin extension), and the presence of four to six red bars on the caudal fin in males (*vs.* eight).

Table 1. Morphometric data of *Melanorivulus atlanticus*.

	holotype	paratypes	
	male	males (4)	females (4)
Standard length (mm)	17.3	15.8–17.8	13.1–14.9
Percent of standard length			
Body depth	21.4	20.1–22.6	21.6–22.4
Caudal peduncle depth	14.3	13.2–14.2	12.9–14.3
Pre-dorsal length	76.2	76.5–81.1	80.8–82.0
Pre-pelvic length	55.5	54.9–58.8	56.0–58.5
Length of dorsal-fin base	10.9	9.4–10.8	8.8–10.6
Length of anal-fin base	21.8	18.3–21.8	17.2–19.6
Caudal-fin length	41.3	40.5–40.7	41.4–43.0
Pectoral-fin length	20.8	20.9–23.2	22.0–23.0
Pelvic-fin length	11.4	12.0–13.4	9.6–10.6
Head length	26.7	27.0–28.8	27.9–30.0
Percent of head length			
Head depth	62.5	59.3–63.2	61.9–62.6
Head width	68.5	69.4–73.6	67.5–71.6
Snout length	12.7	11.9–14.2	12.0–13.3
Lower jaw length	15.9	16.4–18.2	14.7–16.7
Eye diameter	35.9	36.0–37.7	36.0–37.4

Description. Morphometric data appear in Table 1. Largest male examined 17.8 mm SL, largest female 14.9 mm SL. Dorsal and ventral profiles between snout and posterior end of dorsal and anal fins, about straight on of caudal peduncle. Body slender, sub-cylindrical anteriorly, slightly deeper than wide, compressed posteriorly. Greatest body depth at vertical just in front to pelvic-fin base. Jaws short, snout blunt in lateral view.

Fig. 1. *Melanorivulus atlanticus*: UFRJ 10243, holotype, male, 17.3 mm SL: Brazil: Sergipe: Pirambu.

Dorsal and anal fins short, extremity slightly pointed in males, rounded in females. Caudal fin oval, longer than deep. Pectoral fin rounded, posterior margin reaching vertical at about 90 % of length between pectoral-fin and pelvic-fin bases. Pelvic fin pointed in males, tip reaching between urogenital papilla and base 2nd anal-fin ray, elliptical in females, reaching between anus and urogenital papilla; pelvic-fin bases medially in close proximity. Dorsal-fin origin on vertical through base of 10th anal-fin ray; second proximal radial of dorsal fin between neural spines of 18th and 20th vertebrae, first proximal radial of anal fin between pleural ribs of 13th and 15th vertebrae. Dorsal-fin rays 8–9; anal-fin rays 12–13; caudal-fin rays 26–28; pectoral-fin rays 11–12; pelvic-fin rays 7 in males, 5 in females.

Scales small, cycloid. Body and head entirely scaled, except anterior ventral surface of head. Body squamation extending over anterior 25 % of caudal-fin base; no scales on dorsal and anal-fin bases. Frontal squamation F- or sometimes E-patterned; E-scales not overlapping medially; scales arranged in regular circular pattern around A-scale without exposed margins. Longitudinal series of scales 27–28; transverse series of scales 8; scale rows around caudal peduncle 16. No contact organs.

Cephalic neuromasts: supraorbital (1+2)+3, parietal 1, anterior rostral 1, posterior rostral 1, infraorbital 1+10+1, preorbital 1, otic 1, post-otic 1, supratemporal 1, median opercular 1, ventral opercular 1, pre-opercular 2+4, mandibular 2+1, lateral mandibular 1, paramandibular 1.

Basihyal sub-triangular, greatest width about 35 % of length; basihyal cartilage about 15 % of total length of basihyal. Five branchiostegal rays. Second pharyngobranchial teeth absent. Gill-rakers on first branchial arch 1+7. Vomerine teeth 2–3. Dermosphenotic well developed. Ventral process of posttemporal absent. Total vertebrae 28–29.

Colouration. ***Males***. Flank light grey with pale blue iridescence; dark grey to black stripe between postorbital region and caudal-fin base mainly visible when fish is exposed to strong light; irregular oblique red bars, more concentrated on posterior half of body side. Dorsum light brown, venter white. Dorsal portion of head side light brown, ventral portion white. Upper jaw light brown, lower jaw black. Iris pale yellow. Dorsal and anal fins fin pale blue with oblique dark red bars on basal and posterior portions of fins; dark reddish grey to black stripe on distal margin of anal fin. Caudal fin pale yellow, with 5 or 6 narrow red bars, and narrow black border on whole fin margin. Pectoral fin hyaline. Pelvic fin pale blue with dark red anterior margin.

***Females*.** Similar to males, except by unpaired and pelvic fins white, with distal black margin on dorsal and anal fins, entire black margin on caudal fin, and black anterior margin on pelvic fin; rounded black spot on dorsal portion of caudal-fin base, and vertically elongated black spots on middle of caudal fin.

Distribution and habitat. Known only from the type locality in the coastal plains of northeastern Brazil, between the villages of Lagoa Grande and Pau Seco, Estado de Sergipe.

Etymology. The name *atlanticus* refers to the first record of the genus *Melanorivulus* for the Atlantic Forest region of northeastern Brazil.

Discussion

The description of *M. atlanticus* greatly expands the known geographic range of the genus *Melanorivulus*, consisting of the eastern-most record and the first collecting site within the Atlantic Forest biogeographical province. Species of this genus have been previously recorded from open vegetation savannah areas, in the biogeographical provinces of the Amazon, Caatinga, Cerrado,

Pantanal and Chaco (Bastos & Lourenço, 1983; Costa, 2005, 2006a–b, 2007b–c, 2008b; Schindler & Etzel, 2008; Bragança *et al*., 2012), but the new species was also found in an open vegetation habitat inserted in a coastal Restinga area. Until now, the eastern-most record of the genus was the type locality of *M. decoratus* (Costa, 1989), situated in the northern portion of the São Francisco river basin, near the village of Ibiraba (Costa, 1989). The type locality of *M. atlanticus* is placed 670 km E from the type locality of *M. decoratus*, which probably is the closest relative of *M. atlanticus*. *Melanorivulus atlanticus*, *M. decoratus* and *M. jalapensis* form a well-supported clade of miniature species not surpassing 20 mm SL, diagnosed by the presence of five branchiostegal rays (*vs*. six in all other species of the genus).

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