

Four new species of the genus *Atlantirivulus* (Cyprinodontiformes: Rivulidae) from the Brazilian Atlantic Forest

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Abstract

Material obtained from recent collections was used to revise taxonomy of the genus *Atlantirivulus* in the coastal basins of south–eastern Brazil, making possible to recognise four new species: *Atlantirivulus maricensis*, new species, from the rivers drainages connected to the Maricá lagoon system; *Atlantirivulus guanabarensis*, new species, from river drainages flowing into the Guanabara bay; *Atlantirivulus paranaguensis*, new species, from the river basins of the plain area adjacent to the Paranaguá bay; and *Atlantirivulus ribeirensis*, new species, from the Ribeira de Iguape river basin. All the new species herein described are members of the *A. santensis* species group, diagnosed by the lateral line being divided in two sections. *Atlantirivulus maricensis* is considered to be closely related to *A. janeiroensis*, *A. jurubatibensis* and *A. nudiventris* by all sharing a horizontally elongated female caudal spot, whereas *A. guanabarensis* seems to be more closely related to *A. lazzarotoi* and *A. simplicis*, by all having a high number of neuromasts in the section of infraorbital series around orbit, and *A. paranaguensis* seems to be more closely related to *A. santensis* by both having the anal and caudal fin margin highly black pigmented in males; relationships of *A. ribeirensis* among congeners is unclear, but the presence of intense yellow pigmentation on venter suggests close relationships with *A. santensis*. Characters used to diagnose new species include colour patterns, number of scales in the longitudinal series and vertebrae, and shape of caudal fin.

Key words

Atlantic Forest, Biodiversity, Killifish, Systematics, Taxonomy.

Introduction

The Atlantic Forest is a South American biogeographical province extending as a narrow strip of dense rain forest along the coastal region of eastern Brazil (e.g., MORRONE, 2006), between 6° and 29° S. With a rich diversity of endemic plants and animals, the Atlantic Forest has been considered to be among the five richest biodiversity hotspots in the world (MYERS *et al.*, 2000). Killifishes of the family Rivulidae are well represented in this province, including 10 genera, of which eight are endemic, and over 40 species (COSTA, 2009, 2010). Among endemic

genera is *Atlantirivulus*, presently with 10 valid species (COSTA, 2011).

Taxonomy of *Atlantirivulus* was neglected until recent years, all species being placed in *Rivulus* before the last classification proposal for rivulines (COSTA, 2011). The poor record in scientific collections was an obstacle for detailed taxonomical revisions. Sampled populations usually comprised a single or no adult male above 34 mm SL, one or two smaller adult males between about 28 and 30 mm SL, about three to five adult females, and

several juveniles below 28 mm SL. In addition, most species occurring in south-eastern and southern Brazil have live colours paler than the usual colouration found in rivulids, not showing clear diagnostic characters, except under detailed examination. Consequently, a single species, *Atlantirivulus santensis*, was considered as a geographically widespread taxon, occurring between Rio de Janeiro and Santa Catarina states, in a geographical extent about 900 km along the coastal plains (SEEGERS, 1984). BERKENKAMP (1984) recognised *Atlantirivulus haraldsiolii* (BERKENKAMP, 1984) from Santa Catarina (see also COSTA, 2007a) and COSTA (1991, 2004, 2007b, 2008a) recognised *Atlantirivulus janeiroensis* (COSTA, 1991), *Atlantirivulus simplicis* (COSTA, 2004), *Atlantirivulus lazzarotoi* (COSTA, 2007), and *Atlantirivulus jurubatibensis* (COSTA, 2008) for the coastal plains of Rio de Janeiro state.

The original description of *A. janeiroensis* was based on preserved specimens collected both in the inland river basins, including the São João and Macaé river basins, and in river drainages connected to the Guanabara bay (COSTA, 1991). Subsequently, collections referring to *A. janeiroensis* have been focused on material coming from the Guanabara bay system and adjacent areas, to where colour patterns of live individuals have been well documented, but no additional specimen from the inland basins was sampled, since the only populations known at that time were extinct just after publication of the original description. On the other hand, *A. santensis*, diagnosed by black pigmentation concentrated on the unpaired fin margins in males, was revised and considered as occurring in a broad region encompassing the Ribeira do Iguape river basin and smaller coastal basins in the São Paulo state, as well as small river basins flowing into the Paranaguá bay, Paraná state (COSTA, 2008b). Examination of material obtained in recent new collections along the Atlantic Forest region, including the discovery of new populations of *A. janeiroensis* in two protected biological reserves, made possible to reevaluate the taxonomy of the group, recognising four new species herein described.

Material and methods

Material is deposited in MNRJ, Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro, MZUSP, Museu de Zoologia, Universidade de São Paulo, São Paulo, and UFRJ, Instituto de Biologia, Universidade Federal do Rio de Janeiro, Rio de Janeiro. Comparative material is listed in COSTA (1991, 2004, 2007a, b, 2008a, b). Morphological characters used in this study were obtained from specimens 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 taken in small aquaria one or two days after collection; colour patterns derived from distribution of melanophores on fins were also observed in all preserved specimens. Measurements and counts follow COSTA (1995). 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).

Delimitation of species is according to the methodology of the Population Aggregation Analysis (PAA) (DAVIS & NIXON, 1992), in which species are delimited by a diagnosable unique combination of character states occurring in one or more populations. Characters analysed were morphological characters commonly used in rivulid systematics (e.g., COSTA, 2006a), including morphometric and meristic data, colour patterns, cephalic squamation and cephalic neuromast patterns, and osteology. Morphometric data were obtained only from adult specimens, above 28 mm SL. Differently from a former study (COSTA, 2008b), when comparisons were conducted on the basis of morphological variation found among specimens from different river basins, the present PAA focuses on morphological variation found in each population separately, population being defined as those swamps and adjacent streams geographically isolated from other similar habitats, thus considering different populations even when present in the same river basin. PAA only included populations for which photographs of live individuals, taken as described above, were available, which comprised 13 populations of all the eight valid nominal species of the *A. santensis* complex and seven populations of the four species here first described; as a consequence, type material of new species was restricted to specimens from those populations, with the remaining examined material listed as non-types.

Atlantirivulus maricensis spec. nov.

Figs 1–2, Table 1

Holotype: UFRJ 9822, male, 33.4 mm SL; Brazil: Estado do Rio de Janeiro: Município de Maricá: stream crossing the road to Ponta Negra, near the village of Bananal, Carangueijo river drainage, Maricá lagoon system, 22° 54' 51" S 42° 43' 17" W; W.J.E.M. COSTA *et al.*, 18 November 2011.

Paratypes: UFRJ 8792, 6 males, 19.0–32.2 mm SL, 11 females, 18.1–38.0 mm SL; UFRJ 8793, 1 male, 17.9 mm SL, 3 females, 22.4–24.3 mm SL; UFRJ 8794, 2 males, 28.9–30.9 mm SL, 1 fe-



Fig. 1. *Atlantirivulus maricensis*: UFRJ 9822, holotype, male, 33.4 mm SL: Brazil: Rio de Janeiro: Maricá.



Fig. 2. *Atlantirivulus maricensis*: UFRJ 8792, paratype, female, 31.4 mm SL: Brazil: Rio de Janeiro: Maricá.

male, 31.4 mm SL; collected with holotype. – UFRJ 6302, 7 males, 17.5–23.6 mm SL, 16 females, 14.7–24.7 mm SL; UFRJ 6303, 2 males, 23.1–26.6 mm SL, 1 female, 25.3 mm SL; same locality; W.J.E.M. COSTA *et al.*, 25 Sep. 2005.

Additional material (non-types): UFRJ 4758, 4; Brazil: Estado do Rio de Janeiro: Município de Maricá: Itapeteíú creek, 22° 54' 18" S 42° 48' 44" W; R. IGLESIAS, 30 Aug. 1997.

Diagnosis. Distinguished from all other congeners by the following combination of character states: lateral line divided into two sections (*vs.* single); lateral line with one neuromast by scale (*vs.* lateral line often interrupted by scales without neuromasts); 33–35 scales in the longitudinal series (*vs.* 30–31); 33–34 vertebrae (*vs.* 31–32); 30–31 caudal-fin rays (*vs.* 25–29); small, horizontally elongated black spot on dorsal portion of caudal-fin base in females, not contacting fin margin (*vs.* female caudal spot never horizontally elongated, often triangular or rectangular, reaching fin margin, sometimes spot absent); flank with horizontal rows of red dots in males and small light brown spots in females (*vs.* never a similar colour pattern, red pigmentation when present often forming irregular bars or reticulations in males); caudal fin in

males greenish yellow, sub-dorsal and sub-ventral portions bright yellow, dorsal and marginal region diffuse orangish grey, posterior marginal portion diffuse pale greyish yellow (*vs.* never a similar colour pattern); small red spots on the basal and posterior portions of the dorsal fin in males (*vs.* red spots absent).

Description. Morphometric data appear in Table 1. Dorsal and ventral profiles gently convex from snout to posterior end of dorsal and anal-fin bases, about straight on 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 weakly pointed in lateral view.

Dorsal and anal fins short, extremity rounded. Caudal fin oval, short. Pectoral fin rounded, posterior margin reaching vertical at about 60 % of length between pectoral-fin and pelvic-fin bases. Pelvic fin small, oval, tip reaching urogenital papilla in males, reaching anus in females; pelvic-fin bases medially in close proximity. Dorsal-fin origin on vertical between base of 10th and 11th anal-fin rays; second proximal radial of dorsal fin between neural spines of 21st and 22nd vertebrae, first proximal radial of anal fin between pleural ribs of 15th and

Table 1. Morphometric data of *Atlantirivulus maricensis*.

	holotype	paratypes	
	male	males (4)	females (5)
Standard length (mm)	33.4	28.6–32.2	29.4–38.0
Percent of standard length			
Body depth	23.5	21.6–22.7	22.6–24.7
Caudal peduncle depth	15.4	14.1–14.2	13.4–14.0
Pre-dorsal length	76.3	75.8–77.8	78.8–80.8
Pre-pelvic length	55.0	53.5–57.8	55.7–56.9
Length of dorsal-fin base	11.2	10.1–10.6	8.2–10.1
Length of anal-fin base	21.8	23.2–23.8	20.0–20.8
Caudal-fin length	34.6	36.6–38.4	35.0–37.0
Pectoral-fin length	20.3	19.2–20.8	17.9–19.8
Pelvic-fin length	10.3	9.2–10.2	6.9–8.3
Head length	25.4	25.0–25.9	24.1–24.8
Percent of head length			
Head depth	72.9	68.9–71.4	72.1–78.7
Head width	82.9	78.0–81.4	84.2–91.2
Snout length	16.4	14.3–15.5	13.7–15.9
Lower jaw length	23.4	21.8–23.9	19.1–23.1
Eye diameter	29.3	30.6–32.2	30.0–33.1

16th vertebrae. Dorsal-fin rays 7–9; anal-fin rays 14–16; caudal-fin rays 30–31; pectoral-fin rays 13–14; pelvic-fin rays 5.

Scales small, cycloid. Body and head entirely scaled, except anterior ventral surface of head. Body squamation extending over anterior 30 % of caudal-fin base; no scales on dorsal and anal-fin bases. Frontal squamation E- or F-patterned; E-scales not overlapping medially; F-scale always overlapping G-scale; scales arranged in regular circular pattern around A-scale without exposed margins. Longitudinal series of scales 33–35; transverse series of scales 7; scale rows around caudal peduncle 16. One or two small contact organs per scale of ventral region of middle part of flank in males; no contact organs on fins.

Cephalic neuromasts: supraorbital 3+3, parietal 2, anterior rostral 1, posterior rostral 1, infraorbital 1+17–20+1, preorbital 3, otic 1, post-otic 2, supratemporal 1, median opercular 1, ventral opercular 2, pre-opercular 2+4, mandibular 4+2, lateral mandibular 3, paramandibular 1. Lateral line divided in 2 sections, anterior section between head and vertical just anterior to end of pectoral fin, posterior section on longitudinal series just below anterior section, between vertical through end of pectoral fin and middle portion of caudal-fin base; 1 neuromast by scale of lateral line. Two neuromasts on caudal-fin base.

Basihyal sub-triangular, greatest width about 40 % of length; basihyal cartilage about 20 % of total length of basihyal. Six branchiostegal rays. Second pharyngobranchial teeth 3. Gill-rakers on first branchial arch 1+8. Vomerine teeth 1–2. Dermosphenotic well developed. Ventral process of posttemporal absent. Total vertebrae 33–34.

Colouration. Males. Flank pale greenish blue, with pale pink dots often forming reticulate pattern. Dorsum pale brownish grey, dark greenish brown on lateral portion. Venter white. Dorsal part of head side pale brown, with dark brown spots on post-orbital region and dorsal portion of opercle, ventral portion of opercle metallic yellowish green; post orbital dark brown spots not extending ventrally beyond level of ventral margin of orbit; melanophores concentrated on ventral jaw and pre-orbital region separated from melanophore patches of post-orbital region by not pigmented area below orbit; ventral part of head side white. Iris brown, margin dark green. Dorsal fin yellow, basal portion grey, red spots on basal and posterior portions of fin. Anal fin yellow, basal portion white, distal portion orangish grey; pale red dots on basal and posterior portion of fin. Caudal fin pale greenish yellow, sub-dorsal and sub-ventral portions bright yellow, dorsal and marginal region diffuse orangish grey, posterior marginal portion diffuse pale greyish yellow. Pectoral fin yellowish hyaline. Pelvic fin yellow, anterior margin orangish grey.

Females. Flank dark brown with small light brown spots, mostly arranged in horizontal rows. Dorsum pale brown to dark brown on lateral portion. Venter white. Colour pattern of head as in males, except by paler green iridescence on ventral portion of opercular region; latero-ventral portion of head white. Iris brown, margin dark green. Dorsal fin hyaline with two transverse rows of pale brown dots, often forming stripes. Anal fin orangish pink with sparse faint grey dots, basal portion bluish white. Caudal fin hyaline with transverse rows of small grey spots; horizontally elongated, rounded black spot on dorsal portion of caudal-fin base, not reaching fin margin, with anteriorly adjacent small white spot. Paired fins hyaline.

Distribution and habitat. *Atlantirivulus maricensis* is only known to rivers drainages connected to the Maricá lagoon system, Rio de Janeiro state, south-eastern Brazil. A single not preserved exemplar of *A. maricensis* was first collected in the Itapeteiú creek, near the point where it flows into the Ubatiba river, in December 1980, where the water was tea-coloured, pH 6.4, oxygen dissolved 4.7 mg/l, temperature about 25°C (Costa, 1984). Collection was made in a shallow place close to edge of that creek, under a forest remnant. After 2005, the species has been found in a small, shallow stream, partially protected by a secondary forest remnant, water pH 6.0. In recent years, the area between the Itapeteiú creek and Ubatiba river was severely modified by intense stream bottom sediment extraction and stream bank deforestation, making most fish species of the area extinct. In the type locality area, there is no vestige of the original vegetation, since it was broadly occupied by cattle farms. *Atlantirivulus maricensis* is considered as a critically endangered species.

Etymology. The name *maricensis* is a reference to the occurrence of the new species in the Maricá lagoon system.

Atlantirivulus guanabarensis spec. nov.

Figs 3–5, Table 2

Holotype: UFRJ 9825, male, 31.1 mm SL; Brazil: Estado do Rio de Janeiro: Município de Magé: stream within dense forest, Roncador river basin, Citrolândia, Reserva Particular do Patrimônio Natural Campo Escoteiro Geraldo Hugo Nunes, 22° 35' 31" S 43° 01' 28" W; S. LIMA *et al.*, 16 February 2001.

Paratypes: All collected in the type locality, as described above: UFRJ 5238, 7 males, 15.5–23.3 mm SL, 14 females, 13.8–27.3 mm SL; collected with holotype. – UFRJ 187, 3 males, 23.4–31.2 mm SL, 8 females, 21.8–30.3 mm SL; W.J.E.M. COSTA *et al.*, 20 Oct. 1990. – UFRJ 5239, 3 males, 21.4–33.4 mm SL, 9 females, 14.9–31.1 mm SL; S. LIMA *et al.*, 19 Feb. 2001. – UFRJ 5258, 2 males, 30.9–35.3 mm SL; S. LIMA *et al.*, 21 Apr. 2001. – UFRJ 5260, 4 males, 23.0–27.1 mm SL, 4 females, 20.8–31.4 mm SL; S. LIMA *et al.*, May 2001. – UFRJ 5333, 5 males, 27.8–33.6 mm SL, 3 females, 23.9–29.5 mm SL; S. LIMA & P. HOLANDA, 19 Jul. 2001. – UFRJ 5421, 3 males, 24.0–30.5 mm SL, 3 females, 22.9–24.8 mm SL (c&s); S. LIMA *et al.*, 4 Dec. 2001. – UFRJ 8125, 3 males, 26.0–33.4 mm SL, 4 females, 19.6–24.4 mm SL; S. LIMA *et al.*, 2 Feb. 2002. – UFRJ 5252, 3 males, 21.3–24.7 mm SL, 4 females, 23.9–30.6 mm SL; S. LIMA *et al.*, 30 Mar. 2001.

Additional material (non-types): All from Estado do Rio de Janeiro, Brazil. Município de Magé, Roncador river basin: UFRJ 130, 2 paratypes of *A. janeiroensis* (c&s); UFRJ 152, 9; same locality as holotype; W.J.E.M. COSTA & K. TANIZAKI, 22 Dec. 1989. – UFRJ 5256, 12; *idem*; S. LIMA *et al.*, 21 Apr. 2001. – UFRJ 5331, 11; *idem*; W.J.E.M. COSTA *et al.*, 28 Jun. 2001. – UFRJ 5366, 6; *idem*; S. LIMA *et al.*, 24 Aug. 2001. – UFRJ 5389, 7; *idem*; S. LIMA & J. VALVERDE, 30 Sep. 2001. – UFRJ 5391, 8; *idem*; S. LIMA *et al.*, 26 Oct. 2001. – MNRJ 28081, 7; *idem*; L.N. WEBER, 14 Nov. 2004. Município de Duque de Caxias, Estrela river basin: UFRJ 8886, 4; Barão de Mauá; P. ALMEIDA, 1 Apr. 2012. Município do Rio de Janeiro, Jacarepaguá lagoon system: MNRJ 25304, 4; pool in the Área de Proteção Ambiental das Tabebuias, Recreio dos Bandeirantes; J.R. GOMES, 30 May 2003. – MNRJ 25371, 13; swampy forest in Vargem Grande, near Portela canal; J. R. GOMES, 8 Jan. 2003. – MNRJ 24777, 19; swamp between avenida das Américas and Cortado canal; J.R. GOMES, 22 Dec. 2002. – MNRJ 24775, 11; flooded forest in the area among Cortado, Urubá, and Portela canals; J.R. GOMES, 26 Dec. 2002. – MNRJ 25023, 7; swamp close to canal tributary to Jacarepaguá lagoon, Área de Proteção Ambiental das Tabebuias; J.R. Gomes *et al.*, 11 Dec. 2002. – MNRJ 25421, 2; seasonal pool in Parque Municipal de Marapendi, Recreio dos Bandeirantes; J.R. GOMES, 1 May 2003. – MNRJ 25436, 4; *idem*; J.R. GOMES, 12 Apr. 2003. – MNRJ 25429, 5; swamp near Sernambetiba and Portela canals; J.R. GOMES, 12 Mar. 2003. – MNRJ 25514, 7; *idem*; J.R. GOMES *et al.*, 15 May 2003.

Diagnosis. Distinguished from all other congeners by the following combination of character states: lateral line divided into two sections (*vs.* single); lateral line with one neuromast by scale (*vs.* lateral line often interrupted by scales without neuromasts); 22–26 neuromasts in the

section of infraorbital series around orbit (*vs.* usually 17–22, sometimes 23 or 24); a narrow, well-defined dark reddish grey stripe on the distal margin of the anal fin and ventral margin of the caudal fin in males (*vs.* never a similar colour pattern), melanophore patch on the post-orbital region extending ventrally to the pre-opercular series of neuromasts (*vs.* not reaching pre-opercular series of neuromasts); snout blunt (*vs.* slightly pointed); ventral portion of head and venter white (*vs.* orangish yellow); triangular light blue spots on the flank absent in males (*vs.* present); grey reticulum on the base of the dorsal and anal fins absent in males (*vs.* present).

Description. Morphometric data appear in Table 2. Dorsal and ventral profiles weakly convex from snout to posterior end of dorsal and anal-fin bases, approximately straight on 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.

Dorsal and anal fins short, extremity rounded, sometimes slightly pointed in males. Caudal fin oval, short. Pectoral fin rounded, posterior margin reaching vertical at about 60 % of length between pectoral-fin and pelvic-fin bases. Pelvic fin small, oval, tip reaching between urogenital papilla and base of 2nd anal-fin ray in males, reaching anus in females; pelvic-fin bases medially in close proximity. Dorsal-fin origin on vertical between base of 11th and 13th anal-fin rays; second proximal radial of dorsal fin between neural spines of 21st and 23rd vertebrae, first proximal radial of anal fin between pleural ribs of 14th and 15th vertebrae. Dorsal-fin rays 7–9; anal-fin rays 14–16; caudal-fin rays 29–32; pectoral-fin rays 14; pelvic-fin rays 5–6.

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 E-patterned; E-scales not overlapping medially; F-scale overlapping or overlapped by G-scale; scales arranged in regular circular pattern around A-scale without exposed margins. Longitudinal series of scales 33–34; transverse series of scales 7–8; scale rows around caudal peduncle 16. One or two small contact organs per scale of ventral region of middle part of flank in males; no contact organs on fins.

Cephalic neuromasts: supraorbital 3+3, parietal 1, anterior rostral 1, posterior rostral 1, infraorbital 1+22–26+1, preorbital 3, otic 1, post-otic 2, supratemporal 1, median opercular 1, ventral opercular 2, pre-opercular 2+4, mandibular 4+2, lateral mandibular 3, paramandibular 1. Lateral line divided in 2 sections, anterior section between head and vertical just anterior to end of pectoral fin, posterior section on longitudinal series just below anterior section, between vertical through end of pectoral fin and middle portion of caudal-fin base; 1 neuromast by scale of lateral line.

Basihyal sub-triangular, greatest width about 50 % of length; basihyal cartilage about 25 % of total length



Fig. 3. *Atlantirivulus guanabarensis*: UFRJ 9825, holotype, male, 31.1 mm SL: Brazil: Rio de Janeiro: Magé.



Fig. 4. *Atlantirivulus guanabarensis*: live topotype not preserved, male, about 30 mm SL: Brazil: Rio de Janeiro: Magé.



Fig. 5. *Atlantirivulus guanabarensis*: live topotype not preserved, female, about 30 mm SL: Brazil: Rio de Janeiro: Magé.

of basihyal. Six branchiostegal rays. Second pharyngo-branchial teeth 1–3. Gill-rakers on first branchial arch 1+8. Vomerine teeth 1–3. Dermosphenotic well developed. Ventral process of posttemporal absent. Total vertebrae 33–34.

Colouration. Males. Flank purplish grey, with light green iridescence. Dorsum pale brown to dark brown on

lateral portion. Venter white. Dorsal part of head dark brown, ventral portion of opercle metallic yellowish green; post orbital pigmentation extending ventrally to pre-opercular series of neuromasts; melanophore patch on ventral jaw and pre-orbital region united to melanophore patch on post-orbital region by narrow pigmented area below orbit; ventral part of head side white. Iris brown, margin dark green. Dorsal fin pale yellow, dis-

Table 2. Morphometric data of *Atlantirivulus guanabarensis*.

	holotype	paratypes	
	male	males (8)	females (5)
Standard length (mm)	31.1	30.4–35.3	29.5–31.4
Percent of standard length			
Body depth	22.3	19.3–22.2	18.9–20.2
Caudal peduncle depth	15.0	12.8–14.8	12.5–13.7
Pre-dorsal length	76.1	76.6–79.1	75.7–79.9
Pre-pelvic length	55.2	53.4–56.4	53.6–56.3
Length of dorsal-fin base	10.8	8.0–10.7	7.5–8.5
Length of anal-fin base	22.8	20.0–22.7	17.7–20.0
Caudal-fin length	39.6	39.1–41.3	37.7–40.4
Pectoral-fin length	21.6	19.5–21.5	17.7–19.7
Pelvic-fin length	9.1	8.2–11.3	6.4–8.0
Head length	26.3	23.8–26.0	24.9–25.3
Percent of head length			
Head depth	69.1	65.6–69.5	62.6–69.5
Head width	73.8	76.8–81.5	74.5–86.4
Snout length	13.9	12.3–15.3	14.0–15.4
Lower jaw length	25.2	20.6–25.3	18.6–23.8
Eye diameter	33.0	31.9–35.7	31.5–35.0

tal margin dark grey. Anal fin light yellow, basal portion bluish white, distal margin with narrow reddish brown stripe. Caudal fin pale yellow, often lighter on sub-dorsal portion; narrow reddish brown stripe on dorsal and ventral margins. Pectoral fin yellowish hyaline. Pelvic fin pale yellow with grey margin.

Females. Flank light brown with pale grey dots. Dorsum pale brown to dark brown on lateral portion. Venter light grey to pale orange. Colour pattern of head as in males, except by paler green iridescence on ventral portion of opercular region; latero-ventral portion of head white. Iris light brown. Dorsal fin hyaline with transverse grey stripe. Anal fin orangish hyaline, basal portion bluish white. Caudal fin hyaline to orangish hyaline on ventral portion, with transverse grey bars; triangular or rectangular black spot on dorsal portion of caudal-fin base, its dorsal tip reaching fin margin or close to it. Pectoral fin hyaline. Pelvic fin orangish hyaline.

Distribution and habitat. *Atlantirivulus guanabarensis* is found in the various river drainages flowing into the Guanabara bay, and adjacent coastal plains to west, including the Jacarepaguá lagoon system, Rio de Janeiro state, south-eastern Brazil. In the type locality, a swampy area within dense forest, in the Roncador river basin, *A. guanabarensis* is a common species. This area is part of a private reserve (Reserva Particular do Patrimônio Natural Campo Escoteiro Geraldo Hugo Nunes), where *Kryptolebias brasiliensis* (Valenciennes, 1821) is also found, but the two species are rarely syntopic. Whereas *K. brasiliensis* inhabits stagnant parts of flowing streams, *A. guanabarensis* is mostly found in shallow pools adjacent to streams. The geographical distribution of *A. guanabarensis* encompasses urban areas both within the city

of Rio de Janeiro and in other large Rio's satellite cities, where aquatic habitats were destroyed in recent decades. However, the species is also found in protected areas, including its type locality, thus considered as not threatened with extinction.

Etymology. The name *guanabarensis* is an allusion to the occurrence of the new species in river drainages flowing into the Guanabara bay.

Atlantirivulus paranaguensis spec. nov.

Figs 6–7, Table 3

Holotype: UFRJ 9794, male, 43.9 mm SL; Brazil: Estado do Paraná: Município de Paranaguá: stream crossing the road PR–407, about 2 km from Vila dos Comerciantes, town of Paranaguá, 25° 36' 03" S 48° 33' 28" W; W.J.E.M. COSTA *et al.*, 29 September 2013.

Paratypes: All from Município de Paranaguá, Estado do Paraná, Brazil. UFRJ 9793, 1 male, 27.3 mm SL, 2 females, 22.7–33.4 mm SL; collected with holotype. – UFRJ 5217, 2 males, 25.1–28.5 mm SL, 5 females, 25.2–31.1 mm SL; pool into forest, close to the road PR–508, near Matinhos, 25° 47' 28" S 48° 33' 42" W; W.J.E.M. COSTA *et al.*, 3 Nov. 2000. – UFRJ 6362, 3 males, 22.2–33.2 mm SL, 14 females, 21.1–35.8 mm SL; UFRJ 6363, 2 males, 25.4–27.2 mm SL, 2 females, 32.4–34.9 mm SL (c&s); swamp close to the road PR–407, near Pery river, about 1 km of Praia de Leste, 25° 41' 21" S 48° 29' 16" W; W.J.E.M. COSTA *et al.*, 15 Dec. 2005.

Additional material (non–types): MZUSP 35413, 3; Paranaguá; W.J.E.M. COSTA *et al.*, 21 Dec. 1986. – MNRJ 19551, 24; km 11 of the Praias road; C.A.G. CRUZ & E. IZECKSOHN, 10 May 1974. – MNRJ 19494, 24; idem; C.A.G. CRUZ & E. IZECKSOHN, 16 Oct. 1971.

Diagnosis. Distinguished from all other congeners by the following combination of character states: lateral line divided into two sections (*vs.* single); lateral line with one neuromast by scale (*vs.* lateral line often interrupted by scales without neuromasts); caudal fin oval in both sexes (*vs.* sub-truncate at least in males); caudal fin margins, in males, with high concentration of melanophores, forming a well-delimited black ventral margin about thrice wider than a black dorsal margin (*vs.* melanophores, when highly concentrated, forming diffuse black zones on the entire caudal fin, darker and slightly wider on the ventral portion); venter white (*vs.* yellow); female caudal-fin spot always conspicuous (*vs.* spot pale or absent in females above 28 mm SL).

Description. Morphometric data appear in Table 3. Dorsal and ventral profiles slightly convex from snout to posterior end of dorsal and anal-fin bases, nearly straight on caudal peduncle. Body slender, sub-cylindrical anteriorly, slightly deeper than wide, compressed posteriorly.



Fig. 6. *Atlantirivulus paranaguensis*, UFRJ 9794, holotype, male, 43.9 mm SL: Brazil: Paraná: Paranaguá.



Fig. 7. *Atlantirivulus paranaguensis*, UFRJ 6362, paratype, female, 34.0 mm SL: Brazil: Paraná: Paranaguá.

Greatest body depth at vertical just in front to pelvic-fin base. Jaws short, snout weakly pointed in lateral view.

Dorsal and anal fins short, extremity rounded. Caudal fin oval, short. Pectoral fin rounded, posterior margin reaching vertical at about 60 % of length between pectoral-fin and pelvic-fin bases. Pelvic fin small, oval, tip reaching urogenital papilla in males, reaching anus in females; pelvic-fin bases medially in close proximity. Dorsal-fin origin on vertical between base of 10th and 12th anal-fin rays; second proximal radial of dorsal fin between neural spines of 21st and 23rd vertebrae, first proximal radial of anal fin between pleural ribs of 15th and 17th vertebrae. Dorsal-fin rays 7–10; anal-fin rays 14–16; caudal-fin rays 31–34; pectoral-fin rays 13–14; pelvic-fin rays 5–6.

Scales small, cycloid. Body and head entirely scaled, except anterior ventral surface of head. Body squamation extending over anterior 40 % of caudal-fin base; no scales on dorsal and anal-fin bases. Frontal squamation E-patterned; E-scales not overlapping medially; F-scale always overlapped by G-scale; scales arranged in regular circular pattern around A-scale without exposed margins. Longitudinal series of scales 34–36; transverse

series of scales 8–9; scale rows around caudal peduncle 16. One or two small contact organs per scale of ventral region of middle part of flank in males; no contact organs on fins.

Cephalic neuromasts: supraorbital 3+3, parietal 2, anterior rostral 1, posterior rostral 1, infraorbital 1+18–22+1, preorbital 3, otic 1, post-otic 2, supratemporal 1, median opercular 1, ventral opercular 2, pre-opercular 2+4, mandibular 4+2, lateral mandibular 4–5, paramandibular 1. Lateral line divided in 2 sections, anterior section between head and vertical just anterior to end of pectoral fin, posterior section on longitudinal series just below anterior section, between vertical through end of pectoral fin and middle portion of caudal-fin base; 1 neuromast by scale of lateral line. Two neuromasts on caudal-fin base.

Basihyal sub-triangular, greatest width about 50 % of length; basihyal cartilage about 30 % of total length of basihyal. Six branchiostegal rays. Second pharyngo-branchial teeth 2–3. Gill-rakers on first branchial arch 1+7–8. Vomerine teeth 3. Dermosphenotic well developed. Ventral process of posttemporal absent. Total vertebrae 34–36.

Table 3. Morphometric data of *Atlantirivulus paranaguensis*.

	holotype	paratypes	
	male	males (2)	females (5)
Standard length (mm)	43.9	28.5–33.2	30.6–35.8
Percent of standard length			
Body depth	22.8	19.6–21.8	20.5–22.1
Caudal peduncle depth	14.9	12.1–13.5	12.5–13.5
Pre-dorsal length	77.3	73.0–77.9	76.1–79.2
Pre-pelvic length	56.1	52.6–53.9	51.6–57.5
Length of dorsal-fin base	9.7	8.9–11.0	9.0–10.5
Length of anal-fin base	21.8	23.6–23.7	19.3–22.5
Caudal-fin length	35.7	38.0–39.1	34.3–41.3
Pectoral-fin length	18.7	20.0–22.1	18.6–22.3
Pelvic-fin length	9.0	7.9–8.8	7.5–8.4
Head length	25.4	24.3–24.8	22.9–26.4
Percent of head length			
Head depth	75.3	67.7–73.0	64.4–77.3
Head width	80.9	79.2–81.8	78.8–86.5
Snout length	13.8	14.9–16.5	13.2–14.9
Lower jaw length	30.9	19.6–21.1	17.6–25.3
Eye diameter	32.2	31.2–32.5	30.5–33.5

Colouration. Males. Flank pale greenish blue, with pale pink dots often forming narrow oblique irregular bars. Dorsum pale brownish grey. Venter white. Dorsal part of head side pale brown, melanophores strongly concentrated on pre-orbital, post-orbital and supra-opercular portions, ventral portion of opercle metallic green; post-orbital patch of melanophores not extending ventrally beyond level of ventral margin of orbit; pre-orbital melanophore patch connected to post-orbital melanophore patch by narrow pigmented area below orbit; ventral part of head side white. Iris brown, margin dark green. Dorsal fin yellow, distal portion lighter; basal portion of fin light grey with yellow dots; sometimes narrow black distal margin. Anal fin yellow, basal portion white, distal margin dark grey to black; light blue dots on posterior part of sub-basal portion of fin. Caudal fin pale yellow, with broad ventral and narrow dorsal black margin, ventral margin twice or thrice wider than dorsal margin; posterior portion of fin with dark grey zone continuous to dorsal and ventral black margins; often light blue dots on middle part of fin. Pectoral fin yellowish hyaline. Pelvic fin yellow.

Females. Flank light brown with faint oblique pink bars. Dorsum pale brown, with small dark brown spots. Venter pale yellowish brown. Head brown, with pale green iridescence on ventral portion of opercular region; latero-ventral portion of head white. Iris yellow, margin dark green. Dorsal fin hyaline with pale brown dots. Anal fin orangish pink with sparse grey dots, basal portion bluish white. Caudal fin hyaline with narrow grey bars; dark grey to black spot on dorsal portion of caudal-fin base, reaching fin margin. Paired fins hyaline.

Distribution and habitat. Uniquely found in shallow swamps and channels connected to small streams, within

dense forest areas, in small river basins flowing into the Paranaguá bay. The water was light yellow or tea-like coloured, the habitat bottom consisting of litter. In a locality near the Pery river, the water pH was 6.1. No other fish species was found in this habitat. *Atlantirivulus paranaguensis* is not an endangered species, since the area in its geographical range comprises a vast extent of well-preserved dense rain forest.

Etymology. The name *paranaguensis* is a reference to the occurrence of the new species in the plains associated to the Paranaguá bay.

Atlantirivulus ribeirensis spec. nov.

Figs 8–9, Table 4

Holotype: UFRJ 9800, male, 28.8 mm SL; Brazil: Estado de São Paulo: Município de Juquiá: swamp in the road about 5 km W from Juquiá, 24° 20' 00" S 47° 38' 51" W; W.J.E.M. COSTA *et al.*, 13 Dec. 2005.

Paratypes: All from the Ribeira de Iguape river basin, São Paulo state, Brazil. Município de Juquiá: UFRJ 6329, 3 males, 22.8–27.2 mm SL, 8 females, 28.6–33.8 mm SL; UFRJ 6330, 1 female, 30.4 mm SL; UFRJ 6605, 3 males, 20.3–23.7 mm SL, 2 females, 18.9–23.1 (c&s); collected with holotype. Município de Iguape: UFRJ 6326, 1 male, 28.0 mm SL, 2 females, 31.5–32.1 mm SL; UFRJ 6607, 1 male, 24.2 mm SL, 1 female, 20.0 mm SL (c&s); swamp between Iguape and Sabaúna, road SP–222, 24° 45' 15" S 47° 37' 40" W; W.J.E.M. COSTA *et al.*, 12 Dec. 2005.

Additional material (non–types): All from the Ribeira de Iguape river basin, São Paulo state, Brazil. MZUSP 38385, 21; Estação Ecológica da Juréia; J.C. OLIVEIRA, 23 Feb. 1985. – MZUSP 35305, 2; Miracatu; O.T. OYAKAWA, 29 Jul. 1985. – MNRJ 24352, 1; Juquiá; P. BUCKUP *et al.*, 16 Feb. 2002. – MNRJ 19467, 14; Registro; C.A.G. CRUZ *et al.*, 22 Nov. 1973. – MNRJ 25773, 4; *idem*; C.A.G. CRUZ & E. IZECKSOHN, 16 Oct. 1971. – MNRJ 19454, 1; *idem*; J.G. SILVA *et al.*, 3 Nov. 1972. – UFRJ 5439, 12; Cardoso island, near praia da Tapera; S. LIMA & J. VALVERDE, 25 Jul. 2001. – MNRJ 19486, 1; Estação Experimental de Pariquera–Açu; J. JIM, 17 Dec. 1973.

Diagnosis. Distinguished from all other congeners by the following combination of character states: lateral line divided into two sections (*vs.* single); lateral line with one neuromast by scale (*vs.* lateral line often interrupted by scales without neuromasts); caudal fin oval in both sexes (*vs.* sub-truncate at least in males); caudal fin, in males, with narrow dark grey stripe along whole fin margin (*vs.* never a similar colour pattern); venter yellow (*vs.*); female caudal-fin spot always conspicuous (*vs.* spot pale or absent in females above 28 mm SL).

Description. Morphometric data appear in Table 4. Dorsal and ventral profiles weakly convex from snout to



Fig. 8. *Atlantirivulus ribeirensis*, UFRJ 9800, holotype, male, 28.8 mm SL: Brazil: São Paulo: Juquiá.



Fig. 9. *Atlantirivulus ribeirensis*, UFRJ 6326, paratype, female, 30.4 mm SL: Brazil: São Paulo: Iguape.

posterior end of dorsal and anal-fin bases, nearly straight on 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 weakly pointed in lateral view.

Dorsal and anal fins short, extremity rounded. Caudal fin oval, short. Pectoral fin rounded, posterior margin reaching vertical at about 70 % of length between pectoral-fin and pelvic-fin bases. Pelvic fin small, oval, tip reaching between anus and urogenital papilla in males, reaching anus in females; pelvic-fin bases medially in close proximity. Dorsal-fin origin on vertical between base of 11th and 13th anal-fin rays; second proximal radial of dorsal fin between neural spines of 21st and 23rd vertebrae, first proximal radial of anal fin between pleural ribs of 14th and 16th vertebrae. Dorsal-fin rays 8–10; anal-fin rays 14–17; caudal-fin rays 29–30; pectoral-fin rays 13–14; pelvic-fin rays 5–6.

Scales small, cycloid. Body and head entirely scaled, except anterior ventral surface of head. Body squamation extending over anterior 30 % of caudal-fin base; no scales on dorsal and anal-fin bases. Frontal squamation E-patterned; E-scales not overlapping medially; F-scale always overlapped by G-scale; scales arranged in regular circular pattern around A-scale without exposed margins. Longitudinal series of scales 33–35; transverse series of

scales 7–8; scale rows around caudal peduncle 16. One or two small contact organs per scale of ventral region of middle part of flank in males; no contact organs on fins.

Cephalic neuromasts: supraorbital 3+3, parietal 2, anterior rostral 1, posterior rostral 1, infraorbital 1+19–22+1, preorbital 3, otic 1, post-otic 2, supratemporal 1, median opercular 1, ventral opercular 2, preopercular 2+4, mandibular 4+2, lateral mandibular 4–5, paramandibular 1. Lateral line divided in 2 sections, anterior section between head and vertical just anterior to end of pectoral fin, posterior section on longitudinal series just below anterior section, between vertical through end of pectoral fin and middle portion of caudal-fin base; 1 neuromast by scale of lateral line. Two neuromasts on caudal-fin base.

Basihyal sub-triangular, greatest width about 60 % of length; basihyal cartilage about 30 % of total length of basihyal. Six branchiostegal rays. Second pharyngobranchial teeth 2. Gill-rakers on first branchial arch 1+8. Vomerine teeth 2. Dermosphenotic well developed. Ventral process of posttemporal absent. Total vertebrae 33–35.

Colouration. Males. Flank pale greenish blue, with pale pink oblique bars. Dorsum pale brownish grey. Venter yellow. Dorsal part of head side pale brown, melano-

Table 4. Morphometric data of *Atlantirivulus ribeirensis*.

	holotype	paratypes	
	male	males (1)	females (10)
Standard length (mm)	28.8	28.0	28.3–33.8
Percent of standard length			
Body depth	21.3	20.8	20.7–22.8
Caudal peduncle depth	13.4	13.6	11.8–13.8
Pre-dorsal length	77.4	77.8	78.1–81.0
Pre-pelvic length	56.5	56.4	52.7–57.0
Length of dorsal-fin base	9.0	10.1	7.8–10.9
Length of anal-fin base	22.7	22.9	19.9–23.8
Caudal-fin length	37.9	34.9	33.0–39.1
Pectoral-fin length	20.1	18.9	18.6–20.3
Pelvic-fin length	8.3	7.8	6.2–8.0
Head length	26.2	24.7	24.6–26.0
Percent of head length			
Head depth	66.3	68.1	64.3–74.6
Head width	73.6	77.6	74.4–86.8
Snout length	15.0	13.3	13.1–16.6
Lower jaw length	22.0	19.2	20.7–25.4
Eye diameter	30.9	34.1	30.2–32.8

phores concentrated on pre-orbital, post-orbital and supra-opercular portions, ventral portion of opercle greenish golden; post-orbital patch of melanophores not extending ventrally beyond level of ventral margin of orbit; pre-orbital melanophore patch connected to post-orbital melanophore patch by narrow pigmented area below orbit; ventral part of head side light yellow. Iris brown, margin dark greenish yellow. Dorsal fin pale yellow, with one or two sub-basal grey transverse stripes; narrow dark grey distal margin. Anal fin yellow, basal portion white, distal margin black. Caudal fin pale yellow, with narrow dark grey stripe along whole fin margin. Pectoral fin yellowish hyaline. Pelvic fin yellow with dark grey or black anterior margin.

Females. Flank light bluish grey with faint pink dots and small pale golden spots. Dorsum pale brown, with dark brown dots. Venter pale yellowish brown. Head brown, with pale green iridescence on ventral portion of opercular region; latero-ventral portion of head white. Iris yellow, margin dark green. Dorsal fin yellowish hyaline with dark grey dots and vermiculate marks. Anal fin yellowish hyaline with transverse rows of grey dots, basal portion bluish white. Caudal fin hyaline with transverse rows of grey dots; triangular black spot on dorsal portion of caudal-fin base, reaching fin margin. Paired fins hyaline.

Distribution and habitat. *Atlantirivulus ribeirensis* was collected in shallow streams, 10 cm deep or less, within or close to dense forests of the Ribeira de Iguape river basin. In these habitats, the water was light yellow or tea-like coloured, and the habitat bottom was formed by litter and sand. No other fish species was found in these habitats. Since *A. ribeirensis* is found in a broad geographi-

cal extent of dense forests, it is not considered to be an endangered species.

Etymology. The name *ribeirensis* refers to the occurrence of the new species in the Ribeira de Iguape river basin, south-eastern Brazil.

Discussion

All the species herein described are members of a group diagnosable by the lateral line divided in two sections, the anterior one placed between head and vertical just anterior to the end of the pectoral fin, the posterior being placed on the longitudinal series of scales just below the anterior section, between the vertical through the end of the pectoral fin and the middle portion of the caudal-fin base, with both segments having one neuromast by scale. This group also includes *A. haraldsiolii*, *A. janeiroensis*, *A. jurubatibensis*, *A. nudiventris*, *A. riograndensis*, and *A. santensis*, and is hereafter named as the *A. santensis* species group. In *A. luelingi*, the lateral line is also divided in two sections, but both scale row sections are often interrupted by scales without neuromast. The anterior section is absent in the remaining species of *Atlantirivulus* and in closely related genera, all of which have the lateral line interrupted by spaces without neuromasts.

Atlantirivulus maricensis is considered to be closely related to *A. janeiroensis*, *A. jurubatibensis* and *A. nudiventris*. In females of all these species, there is a small, horizontally elongated black spot on the dorsal portion of the caudal-fin base, a character state already noted in COSTA (2008a). In all other species the spot is larger, not horizontally elongated, often in contact with the fin margin. Among those three species, *A. maricensis* shares with *A. jurubatibensis* some apomorphic conditions not occurring in other species, including the presence of horizontal rows of red dots and small light brown spots on the flank in males and females, respectively. In other congeners, these marks when present are much more irregularly arranged on the flank. The caudal fin in males is also similar in *A. maricensis* and *A. jurubatibensis*, being greenish yellow, sub-dorsal and sub-ventral portions bright yellow, dorsal and marginal region diffuse orangish grey, posterior marginal portion diffuse pale greyish yellow (vs. yellow with a well-delimited dark band along the whole fin in *A. janeiroensis* and *A. nudiventris*, Fig. 10). *Atlantirivulus maricensis* differs from *A. janeiroensis*, *A. jurubatibensis* and *A. nudiventris* by the presence of red spots on the basal and posterior portions of the dorsal fin in males. It is also distinguished from *A. jurubatibensis* by the former having 33–35 scales in the longitudinal series (vs. 30–31), 33–34 vertebrae (vs. 31–32), and 30–31 caudal-fin rays (vs. 25–29).



Fig. 10. *Atlantirivulus janeiroensis*, UFRJ 9069, male, 35.7 mm SL: Brazil: Rio de Janeiro: Reserva Biológica União.

Some morphological characters suggest that *A. guanabarensis* is more closely related to *A. lazzarotoi* and *A. simplicis* than to other congeners. The high number of neuromasts in the section of infraorbital series around orbit, 22–26 in *A. guanabarensis*, 26–27 in *A. lazzarotoi*, and 24–28 in *A. simplicis*, vs. 24 or less in other congeners, and the presence of a narrow reddish brown stripe on the distal margin of the anal fin and ventral margin of the caudal fin in males support this putative close relationship. *Atlantirivulus guanabarensis* is distinguished from all congeners by a unique colour pattern, in which the melanophore patch on the post-orbital region extends ventrally to the pre-opercular series of neuromasts (Fig. 4). The snout of *A. guanabarensis* has a peculiar blunt shape (Figs. 3–5), contrasting with the slightly pointed snout in other species (Figs. 1–2, 6–10). *Atlantirivulus guanabarensis* is also distinguished from *A. lazzarotoi* by the later species having, in males, the iris blue (vs. yellow), the pelvic fin and the distal portion of the anal fin orangish red (vs. yellow), the distal margin of the dorsal fin and dorsal margin of the caudal fin blue (vs. reddish grey), the ventral portion of head and venter orangish yellow; and from *A. simplicis* by the last species having, in males, small triangular light blue spots on the flank and a grey reticulum on the base of the dorsal and anal fins.

Among congeners, *A. paranaguensis* seems to be more closely related to *A. santensis*, the only other congener in which the anal and caudal fin margin are highly black pigmented in males. On the other hand, *A. ribeirensis*, occurring in a region between the areas inhabited by *A. paranaguensis* to south and *A. santensis* to north, does not exhibit strongly dark pigmented fins, but the latter species is similar to *A. santensis* by both having the venter yellow, making ambiguous interpretation of possible relationships among the three species based on these two characters of the male colour pattern. Both *A. paranaguensis* and *A. ribeirensis* have the caudal oval in both males and females, and the female caudal spot is always conspicuous, whereas in *A. santensis*, the sub-truncate caudal fin morphology is always conspicuous in males

and sometimes in females (COSTA, 2008c: figs. 1–3) and the female caudal-fin spot is inconspicuous in adult females. *Atlantirivulus paranaguensis* is also distinguished from these two species by the broad, well-defined black stripe on the ventral margin of the caudal fin, about three times wider than a similar coloured stripe on the dorsal margin of the fin (Fig. 6; see also COSTA, 2008c: fig. 5), contrasting with the diffuse black pigmentation present in the caudal fin of *A. santensis* and the regular dark grey stripe around the fin in *A. ribeirensis*. The colours are distinctively brighter in males of *A. ribeirensis*, but this condition cannot be objectively used to diagnose species.

The geographical distribution of *A. janeiroensis* is herein restricted to the São João and Macaé river basins, two neighbouring basins which have their middle portions almost in contact along flooded lowlands and flow directly in the Atlantic Ocean, in a region about 100 km east of the Guanabara bay. *Atlantirivulus janeiroensis* is presently found in two protected areas, the Reserva Biológica de Poço das Antas and the Reserva Biológica União, in shallow streams within dense humid forests. Former records for the river basins flowing into the Guanabara refer to *A. guanabarensis*. *Atlantirivulus maricensis*, not previously recorded in the scientific literature, is confined to the Maricá lagoon system, which is geographically isolated, by hills with altitude about 300–900 m, from neighbouring areas, inhabited to west by *A. guanabarensis* and to northeast by *A. janeiroensis*. On the other hand, the geographical distribution of *A. santensis* is restricted to the coastal plains of São Paulo state, thus excluding to south the Ribeira de Iguape river basin, inhabited by *A. ribeirensis*, and, further south, the small river basins flowing into the Paranaguá basin, which are inhabited by *A. paranaguensis*. However, material collected close the mouth of the Ribeira de Iguape river, near the village of Icapara, is here identified as *A. santensis*, consisting of the southern-most record for the species. This record may indicate a composite biogeographical history for the Ribeira de Iguape river basin, already postulated when analysing distribution patterns in the genus *Campellolebias* (COSTA, 2006b). *Campellolebias dorsimaculatus* COSTA, LACERDA

& BRASIL is endemic to the area near Icapara, whereas *C. intermedius* COSTA is only known from the middle Ribeira de Iguape river basin, thus exhibiting a pattern similar to that described for *Atlantirivulus*.

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Corrections & additions to earlier issues

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Five new species of the killifish genus *Anablepsoides* from the Brazilian Amazon (Cyprinodontiformes: Rivulidae)

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Table 3. Morphometric data of *Anablepsoides henschelae*.

	holotype	paratype
	male	female (1)
Standard length (mm)	22.5	16.4
Percent of standard length		
Body depth	18.8	18.5
Caudal peduncle depth	13.3	12.4
Pre-dorsal length	79.4	77.6
Pre-pelvic length	53.3	55.7
Length of dorsal-fin base	6.5	7.0
Length of anal-fin base	16.4	18.8
Caudal-fin length	41.8	45.4
Pectoral-fin length	24.7	25.4
Pelvic-fin length	12.9	10.6
Head length	27.8	28.4
Percent of head length		
Head depth	52.7	52.3
Head width	76.6	74.2
Snout length	14.7	13.3
Lower jaw length	19.4	24.7
Eye diameter	31.6	32.7