

Excerpt from

Ichthyological Exploration of Freshwaters

An international journal for field-orientated ichthyology

**Volume 25
Number 1**

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Ichthyological Exploration of Freshwaters

An international journal for field-orientated ichthyology

Volume 25 · Number 1 · August 2014
pages 1–96, 60 figs., 13 tabs.

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Ichthyological Exploration of Freshwaters is published quarterly

Subscriptions should be addressed to the Publisher:

Verlag Dr. Friedrich Pfeil, Wolfratshauer Str. 27, 81379 München, Germany
PERSONAL SUBSCRIPTION : EURO 100 per Year/volume - 4 issues (includes surface mail shipping)
INSTITUTIONAL SUBSCRIPTION : EURO 180 per Year/volume - 4 issues (includes surface mail shipping)

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CIP-Titelaufnahme der Deutschen Bibliothek

Ichthyological exploration of freshwaters : an international
journal for field-orientated ichthyology. – München : Pfeil.
Erscheint jährl. viermal. – Aufnahme nach Vol. 1, No. 1 (1990)
ISSN 0936-9902

Vol. 1, No. 1 (1990) –

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Printed by PBTisk a.s., Příbram I – Balonka

ISSN 0936-9902
Printed in the European Union

Verlag Dr. Friedrich Pfeil, Wolfratshauer Str. 27, 81379 München, Germany
Phone +49 89 742827-0 · Fax +49 89 7242772 · E-mail: info@pfeil-verlag.de · www.pfeil-verlag.de



Six new species of seasonal killifishes of the genus *Cynolebias* from the São Francisco river basin, Brazilian Caatinga, with notes on *C. porosus* (Cyprinodontiformes: Rivulidae)

Wilson J. E. M. Costa*

Six new species of the seasonal killifish genus *Cynolebias* are described. They are endemic to the Caatinga of the middle São Francisco river basin, a semi-arid savannah region of north-eastern Brazil undergoing intensive habitat loss. *Cynolebias ochraceus*, new species, is closely related to *C. gilbertoi*, differing from it by having more vertebrae, fewer vomerine teeth, more caudal-fin rays and a different colouration in males. *Cynolebias obscurus*, new species, and *C. roseus*, new species, are members of the *C. porosus* group, the former being distinguished from congeners of that group by having a narrow basihyal, the ventral process of autopalatine absent, and a distinct colour pattern in males; and *C. roseus* differing by having contact organs over the internal surface of all the pectoral-fin rays in males. *Cynolebias relictiventer*, new species, *C. parietalis*, new species, and *C. oticus*, new species, are members of the *C. perforatus* group; *C. relictiventer* differs from all congeners of its group by having contact organs only on the seven upper-most rays of the pectoral fin in males, a small ventral process on the autopalatine and gill rakers slightly curved with denticles restricted to margin, and absence of scales on the dorsal-fin base; *C. parietalis*, by having supraorbital and parietal series of neuromasts united and a broad basihyal; and, *C. oticus*, by having the otic and post-otic series of neuromasts often united or in close proximity and the dorsal profile of the head concave in all ontogenetic stages. *Cynolebias albipunctatus* is considered as a synonym of *C. porosus*, which is assumed to be endemic to the São Francisco river basin. Preliminary conservation status assessments indicate that at least two new species, *C. obscurus* and *C. ochraceus*, are endangered.

Introduction

Until 1990, the presence of *Cynolebias* sensu Costa (1998a) in northeastern Brazil was represented by a single specimen of *C. porosus* Steindachner, 1876 collected in Pernambuco, north-eastern Brazil (Steindachner, 1876), although material belonging to an apparently unnamed

species had also been recorded from the Jaguaribe river basin (Myers, 1952). Between 1990 and 1998, six new species were described on the basis of material obtained in sporadic field collections: *C. griseus* Costa, Lacerda & Brasil, 1990, from the upper Tocantins river basin, the only species endemic to a region outside of the semi-arid Caatinga; *C. albipunctatus* Costa & Brasil, 1991,

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C. perforatus Costa & Brasil, 1991, *C. leptocephalus* Costa & Brasil, 1993, and *C. gilbertoi* Costa, 1998 from the São Francisco river basin; and *C. microphthalmus* Costa, 1995 from the Jaguaribe river basin (Costa et al., 1990; Costa & Brasil 1991, 1993; Costa 1995, 1998b). After regular field collections between 1999 and 2000, Costa (2001) provided the first taxonomic revision of *Cynolebias*, recognising five new species: *C. altus* Costa, 2001, *C. attenuatus* Costa, 2001, *C. gibbus* Costa, 2001 from the São Francisco river basin, *C. itapicuruiensis* Costa, 2001 from the Itapicuru river basin, and *C. vazabarrisensis* Costa, 2001 from the Vazabarris river basin. Subsequently, field work directed at seasonal pools in the Caatinga was intensified, when two new species were described from the Paraguaçu and Parnaíba river basin, *C. paraguassuensis* Costa, Suzart & Nielsen, 2007 and *C. parnaibensis* Costa, Ramos, Alexandre & Ramos, 2010 (Costa et al., 2007, 2010). However, material from new collections from unsampled and previously sampled localities in the São Francisco river basin showed previously unrecorded morphological variation, suggesting the existence of additional species.

Moreover, the morphological characters described by Costa (2001) and used in more recent phylogenetic studies (e.g., Costa, 2010) corroborate the existence of three species groups in the São Francisco river basin: (1) a basal clade endemic to the middle São Francisco basin comprising *C. gilbertoi* and an unnamed species (hereafter *C. gilbertoi* group), diagnosed by the presence of 7–8 gill rakers on the first ceratobranchial (vs. 9–12) that are blunt and broad, separated by wide interspace and without denticles (vs. about triangular, in close proximity to each other and with denticles); 13–15 vomerine teeth (vs. 1–3 when vomerine teeth are present); highest body depth at the vertical through midway between the pectoral-fin base and the pelvic-fin insertion (vs. at the vertical through the pectoral-fin base); and light dots on flank in males arranged in vertical series (vs. not arranged in vertical series); (2) a well supported clade endemic to the middle São Francisco basin comprising *C. altus*, *C. attenuatus*, *C. gibbus*, *C. leptocephalus*, *C. perforatus*, and three new species described herein (hereafter *C. perforatus* group), diagnosed by the presence of scales

on the pectoral and anal-fin bases, with scales on the anal-fin base arranged in transverse rows parallel to fin rays (vs. pectoral-fin base without scales and anal-fin base poorly or not scaled, scales when present slightly extending over middle of fin base, not arranged in transverse rows), and high number of vertebrae (35–37 vs. 31–35); and (3) an assemblage comprising species endemic both to the São Francisco basin and other river basins of the Caatinga, including *C. porosus* and two new species described herein (hereafter *C. porosus* group), diagnosed by a combination of morphological character states opposing those occurring in the *C. gilbertoi* and *C. perforatus* groups, including numerous gill rakers (9–12) and pectoral-fin base without scales. The description of six new species of *Cynolebias* based on recently-collected material forms the basis of this study.

Materials and methods

Material examined is deposited in the following collections: BMNH, Natural History Museum, London; MZUSP, Museu de Zoologia, Universidade de São Paulo; NMW, Naturhistorisches Museum, Wien; SMF, Senckenberg-Museum, Frankfurt; UFRJ, Instituto de Biologia, Universidade Federal do Rio de Janeiro; and ZFMK, Zoologisches Forschungsmuseum und Museum Alexander Koenig, Bonn. Morphological characters were obtained from specimens fixed in formalin just after collection, for a period of 10 days, and then transferred to 70 % ethanol. Comparative material is listed in Costa (2001). Morphometric and meristic data were taken following Costa (1995, 2001); measurements are presented as percent of standard length (SL), except for those related to head morphology, which are expressed as percent of head length. Fin-ray counts include all elements. Number of vertebrae and gill rakers were recorded from cleared and stained specimens; the compound caudal centrum was counted as a single element. Osteological preparations (c&s) were made according to Taylor & Van Dyke (1985). Terminology for bones and for cephalic neuromast series follow Costa (2001), for frontal squamation Hoedeman (1958).



Fig. 1. *Cynolebias ochraceus*, UFRJ 9339, holotype, male, 53.2 mm SL; Brazil: Bahia: Bom Jesus da Lapa.

Cynolebias ochraceus, new species

(Fig. 1)

Holotype. UFRJ 9339, male, 53.2 mm SL; Brazil: Estado da Bahia: Município de Bom Jesus da Lapa: temporary pool about 12 km W from the town of Bom Jesus da Lapa, road BR-349, 13°15'42" S 43°31'28" W, altitude 437 m asl; W. J. E. M. Costa et al., 8 May 2009.

Paratypes. UFRJ 6703, 2 females, 44.6–45.0 mm SL; UFRJ 9340, 3 females, 43.9–45.6 mm SL; collected with holotype. – ZFMK 56321-22, 1 male, 57.3 mm SL, 1 female, 50.5 mm SL; UFRJ 9341, 1 male, 53.6 mm SL, 2 females, 43.7–46.9 mm SL (c&s); same locality; W. J. E. M. Costa et al., 13 Feb. 1999. – UFRJ 4859, 2 males, 56.1–57.0 mm SL, 1 female, 52.1 mm SL; UFRJ 9359, 1 male, 44.1 mm SL, 2 females, 44.8–45.8 mm SL (c&s); same locality; W. J. E. M. Costa et al., 4 May 1999.

Additional material (non-type). UFRJ 6794, 1; Brazil: Estado da Bahia: Município de Malhada: temporary pool about 8 km E of the village of Malhada, 14°17'39" S 43°42'32" W; alt. 499 m asl; W. J. E. M. Costa et al., 31 Jan. 2010.

Diagnosis. *Cynolebias ochraceus* is distinguished from *C. gilbertoi*, the only other species of the *C. gilbertoi* group, by having more vertebrae (33–34 vs. 31–32), flank light yellow ochre and anal fin orange-yellow ochre in males (vs. flank pale pinkish brown or light brown, anal fin pink or pinkish grey), and tip of anal-fin filaments reaching basal portion of caudal fin in males (vs. reaching posterior half of caudal fin). In addition, *C. ochraceus* reaches a maximum adult size of 57 mm SL (vs. 37 mm SL for *C. gilbertoi*). Other features useful to distinguish *C. ochraceus* from *C. gilbertoi* are: caudal-fin rays 29–31 (vs. 26–29) and vomerine teeth 9–12 (vs. 11–16), body depth 35.0–37.8 % SL in males (vs. 32.5–35.4 % SL).

Description. Morphometric data as in Table 1. Largest male examined 57.3 mm SL; largest female examined 52.1 mm SL. Dorsal and ventral profiles convex between snout and anterior part of caudal peduncle, nearly straight to caudal-fin base. Body moderately deep; greatest body depth at midway between pectoral-fin base and pelvic-fin insertion. Urogenital papilla cylindrical in males, short, about as long as wide; urogenital opening of females situated in pocket-like structure, overlapping anal-fin origin. Longitudinal series of scales



33–34; transverse series of scales 12–13; scale rows around caudal peduncle 18. One neuromast on each scale of lateral line. Contact organ on scales absent. Total vertebrae 33–34.

Eye positioned dorsolaterally on head. Snout short, blunt. Premaxillary and dentary teeth conical, small, numerous, irregularly arranged, except for external series with large fang-like teeth, slightly curved inside mouth. Vomerine teeth 9–12. Dermosphenotic absent. Scales small, irregularly arranged on frontal region. Cephalic neuromasts: supraorbital 24–27, parietal 3, preopercular plus mandibular 42–50; anterior rostral 2, posterior rostral 2, infraorbital 3–4 + 28–32, preorbital 3, otic 5–7, post-otic 6–8, supratemporal 2, median opercular 1–2, ventral opercular 5–8, lateral mandibular 10–15, paramandibular 1. Gill-rakers on first branchial arch 2 + 9; gill rakers of first ceratobranchial short, broad, separated by wide interspace, without denticles. Six branchiostegal rays. Basihyal subtriangular, width about 55–60 % of length in both sexes; basihyal cartilage short, about 10–15 % of total length of basihyal. Ventral process of autopalatine present.

Dorsal and anal fins sub-triangular in males, posterior extremity gently pointed; filamentous rays on tip of dorsal fin absent; filamentous rays on tip of anal fin, extremities reaching vertical

through caudal-fin base. Dorsal and anal fins rounded in females, without filamentous rays, distal portion of anterior anal-fin rays strongly thickened. Scales on dorsal-fin base absent; few scales extending slightly at middle of anal fin. Caudal fin rounded; scales extending for about basal 30 % of caudal fin. Two neuromasts on caudal-fin base. Pectoral fin elliptical, posterior margin reaching vertical between base of third and sixth anal-fin rays in males; reaching urogenital papilla in females. Scales on pectoral-fin base absent. Ventral process of posttemporal absent. Pelvic-fin tip reaching between base of second and third anal-fin rays; pelvic-fin bases medially separated by interspace. Dorsal-fin origin in vertical between base of third and fourth anal-fin rays. Dorsal-fin origin between neural spines of vertebrae 12 and 14 in males, vertebrae 13 and 15 in females; anal-fin origin between pleural ribs of vertebrae 12 and 14. Dorsal-fin rays 16–18 in males, 14–17 in females; anal-fin rays 18–20 in males, 17–19 in females; caudal-fin rays 28–31; pectoral-fin rays 13–15; pelvic-fin rays 6. Papillate contact organs on inner surface of five dorsal-most rays of pectoral fin in males.

Colouration. Males: Lateral surfaces of body light yellow ochre, with white dots irregularly

Table 1. Morphometric data of *Cynolebias ochraceus* and *C. obscurus*.

	<i>C. ochraceus</i>			<i>C. obscurus</i>		
	holotype	paratypes		holotype	paratypes	
	male	males (4)	females (5)	male	male (1)	female (1)
Standard length (mm)	53.2	53.6–57.3	43.7–52.1	49.3	44.8	38.6
Percent of standard length						
Body depth	36.3	35.0–37.8	35.2–37.3	31.0	31.4	30.2
Caudal peduncle depth	15.9	16.3–18.0	15.4–16.2	16.0	15.0	13.9
Pre-dorsal length	58.2	58.0–59.9	62.3–67.1	63.1	63.9	64.9
Pre-pelvic length	51.4	48.9–50.5	52.0–55.8	54.4	53.6	56.3
Length of dorsal-fin base	30.4	29.4–31.3	23.3–26.0	25.4	25.2	21.7
Length of anal-fin base	33.0	31.4–34.4	24.5–25.6	30.5	29.5	24.8
Caudal-fin length	37.5	34.8–35.9	34.1–38.0	33.1	32.3	33.5
Pectoral-fin length	27.8	27.8–29.4	27.4–29.1	27.1	26.0	27.8
Pelvic-fin length	8.2	8.7–9.4	10.4–11.3	8.5	9.3	8.1
Head length	31.7	29.6–31.4	29.8–34.0	32.3	33.4	34.9
Percent of head length						
Head depth	104	102–109	97–106	90	89	79
Head width	75	74–76	72–78	75	71	66
Snout length	17	16–18	15–16	13	13	12
Lower jaw length	23	20–21	17–20	23	24	21
Eye diameter	26	24–27	25–30	30	30	31



arranged in vertical zones; preserved specimens with 11–14 grey bars, not perceptible in live specimens. Blotches on humeral region absent. Dorsum greyish yellow ochre, venter yellowish white. Lateral surfaces of head pale yellow, with light grey spots on opercular region; brown pigmentation concentrated on posterior supraorbital, ventral infraorbital, parietal, otic and post-otic series of neuromasts. Iris light orangish yellow, with dark brown bar. Dorsal and caudal fins yellow ochre with bluish white dots. Anal fin orange-yellow ochre, with bluish white dots on basal portion, and light blue lines between fin rays on distal portion; filaments dark yellow ochre, tip black. Pectoral fin hyaline. Pelvic fin yellow ochre.

Females: Lateral surfaces of body light pink; 13–16 grey bars on flank, two or three dark grey spots on anteromedial portion of flank, sometimes not visible in live specimens, but always conspicuous in preserved specimens. Blotches on humeral region absent. Dorsum greyish pink, venter white. Lateral surfaces of head pale purple. Iris light yellow, with dark brown bar. Fins hyaline.

Etymology. From the Latin *ochraceus* (ochre) referring to the predominant colour in males. An adjective.

Distribution, habitat and conservation. Known only from the area of the type locality, close to the road BR-349, about 12 km W from the town of Bom Jesus da Lapa. The habitat was first sampled in February and May 1999. At that time, it consisted of a few interconnected temporary pools about 7 km of the São Francisco river margin, maximum depth about 1 m, occupying an area about 300 m², with typical Caatinga vegetation around its margins. In recent years, the area has been completely deforested for agricultural use, resulting in only about 20 m² of the original aquatic environment remaining by 2009. In all the three collecting trips, the species was always rare and has not been found during frequent sampling of temporary pools in neighbouring areas. This small pool is also inhabited by *C. attenuatus*, *Hypsolebias flagellatus* (Costa, 2003), and *H. harmonicus* Costa 2010. A single specimen was also found in a pool near the village of Malhada, about 135 km S of the type locality, suggesting that this species may have a broader geographical distribution in the middle São Francisco basin. Due to its rarity and the highly deforested state of the area

of the type locality, *C. ochraceus* should be considered an endangered species.

Cynolebias obscurus, new species

(Fig. 2)

Holotype. UFRJ 9320, male, 49.3 mm SL; Brazil: Estado da Bahia: Município de Macaúbas: temporary pools close to the road BA-156, about 6 km SE of the town of Macaúbas, Paramirim river drainage, São Francisco river basin, 13°03'10"S 42°36'58"W, altitude 554 m; W. J. E. M. Costa et al., 3 Feb. 2010.

Paratypes. UFRJ 6774, 1 male, 42.5 mm SL, 2 females, 30.8–38.6 mm SL; UFRJ 6775, 4 males, 28.0–32.0 mm SL, 4 females, 29.3–35.1 mm SL; UFRJ 9321, 2 males, 30.0–44.8 mm SL, 1 female, 32.0 mm SL (c&s); all collected with holotype.

Diagnosis. *Cynolebias obscurus* is distinguished from all congeners of the *C. porosus* group by having: distal portion of anal-fin rays grey in males (vs. red); white dots concentrated on middle of flank in males (vs. about equally arranged in the whole flank); basihyal width about 50–55 % of length (vs. about 65–70 %); ventral process of autopalatine absent (vs. present).

Description. Morphometric data as in Table 1. Largest male examined 49.3 mm SL; largest female examined 38.6 mm SL. Dorsal and ventral profiles slightly convex between snout and end of dorsal and anal fin bases, approximately straight at caudal peduncle. Body moderately slender; greatest body depth at level of pectoral-fin base. Urogenital papilla cylindrical in males, short, about as long as wide; urogenital opening of females situated in pocket-like structure, overlapping anal-fin origin. Longitudinal series of scales 33–35; transverse series of scales 14; scale rows around caudal peduncle 26. Contact organ on scales absent. One neuromast on each scale of lateral line. Total vertebrae 34–35.

Eye positioned dorsolaterally on head. Snout short, blunt. Premaxillary and dentary teeth conical, small, numerous; irregularly arranged, except for external series with large fang-like teeth, slightly curved inside mouth. Vomerine teeth absent. Dermosphenotic absent. Scales small, irregularly arranged on frontal region. Cephalic neuromasts: supraorbital 30–32, parietal 5–7, pre-



Fig. 2. *Cynolebias obscurus*, UFRJ 9320, holotype, male, 49.3 mm SL; Brazil: Bahia: Macaúbas.

opercular plus mandibular 59–61; anterior rostral 2–3, posterior rostral 2–4, infraorbital 4–5 + 34–39, preorbital 3–4, otic 7–9, post-otic 7, supratemporal 3, median opercular 1, ventral opercular 5–6, lateral mandibular 16–17, paramandibular 1. Gill rakers on first branchial arch 3 + 9, gill rakers about triangular, slightly curved, length about twice width, in close proximity, with denticles. Six branchiostegal rays. Basihyal sub-triangular, width about 50–55 % of length in both sexes; basihyal cartilage short, about 25 % of total length of basihyal. Autopalatine narrow, ventral process absent.

Dorsal and anal fins sub-triangular in males, posterior tip gently pointed; anal fin rounded in females, distal portion of anterior anal-fin rays strongly thickened. Scales on dorsal-fin base absent; few scales extending slightly to middle of anal-fin base. Caudal fin rounded; scales extending for about basal 25 % of caudal fin. Two neuromasts on caudal-fin base. Pectoral fin long, elliptical, posterior margin reaching vertical between base of fourth and fifth anal-fin rays in males, and base of third anal-fin ray in females. Scales on pectoral-fin base absent. Ventral process of posttemporal absent. Pelvic fin tip reaching base of fourth anal-fin ray in males, and base of second anal-fin ray in females. Pelvic-fin bases medially separated by interspace. Dorsal-fin origin at vertical between base of fifth and seventh anal-fin rays in males, on base of fourth anal-fin ray in females. Dorsal-fin origin between neural

spines of vertebrae 15 and 16 in males, vertebrae 17 and 18 in females; anal-fin origin between pleural ribs of vertebrae 13 and 14 in males, vertebrae 14 and 15 in females. Dorsal-fin rays 17–18 in males, 16 in females; anal-fin rays 21–22 in males, 19 in females; caudal-fin rays 30–31; pectoral-fin rays 14; pelvic-fin rays 6. Minute papillate contact organs on inner surface of all pectoral-fin rays in males.

Colouration. Males: Dorsal and lateral surfaces of body dark grey, with 16–18 narrow dark brown bars; pale blue dots concentrated on middle of flank. One to three dark brown blotches on humeral region. Venter yellowish white. Lateral surfaces of head pale blue; reddish brown pigmentation concentrated on posterior supraorbital, ventral infraorbital, parietal, otic and post-otic series of neuromasts. Iris light orangish yellow, with dark brown bar. Unpaired fins dark grey with bluish white dots; distal portion of caudal fin light bluish grey. Pectoral fin hyaline. Pelvic fin dark grey.

Females: Lateral and dorsal surfaces of body pale brownish grey; black spot on anteromedial portion of flank. One to three dark brown blotches on humeral region. Venter white. Lateral surfaces of head pale blue; faint brown pigmentation concentrated on posterior supraorbital, ventral infraorbital, parietal, otic and post-otic series of neuromasts. Iris light yellow, with dark reddish brown bar. Fins hyaline.



Fig. 3. *Cynolebias roseus*, UFRJ 9330, holotype, male, 46.6 mm SL; Brazil: Bahia: Barra.

Etymology. From the Latin *obscurus* (dark), referring to the predominant dark grey colouration in males of this species. An adjective.

Distribution, habitat and conservation. *Cynolebias obscurus* is only known from the type locality. It was found in vestigial small pools adjacent to the road BA-156, near the town of Macaúbas. The pools measuring about 3 m wide extend close and parallel to the road for about 1 km. The area is situated in the Paramirim river drainage, a right tributary of the São Francisco river. The entire region around the pool is composed of plantations, without any vestige of the original habitat. The species is sympatric with *Hypsolebias macaubensis* (Costa & Suzart, 2006). Considering the considerable agricultural pressure in the few remaining habitats and the reduced area of occupancy, *C. obscurus* is considered a critically endangered species.

Cynolebias roseus, new species
(Fig. 3)

Holotype. UFRJ 9330, male, 46.6 mm SL; Brazil: Estado da Bahia: Município de Barra: temporary pool close to road BA-161, about 15 km N of the town of Barra, São Francisco river floodplains, 10°58'28" S 43°03'00" W, altitude 410 m asl; W. J. E. M. Costa et al., 11 May 2009.

Paratypes. UFRJ 9331, 1 male, 43.2 mm SL, 3 females, 32.5–34.1 mm SL (c&s); UFRJ 9332, 1 male, 42.5 mm SL, 10 females, 30.0–52.3 mm SL; UFRJ 6724, 4 females, 33.3–35.6 mm SL; collected with holotype.

Diagnosis. *Cynolebias roseus* is distinguished from all congeners of the *C. porosus* group by having contact organs over the internal surface of all the pectoral-fin rays in males (vs. contact organs restricted to the dorsalmost pectoral-fin rays). It is further distinguished from the two other members of the *C. porosus* group endemic to the São Francisco river basin, *C. porosus* and *C. obscurus*, by the following combination of characters: upper jaw not ventrally displaced (vs. ventrally displaced in *C. porosus*); flank pale golden to light pink in males (vs. dark brown in *C. obscurus*), distal portion of anal-fin rays red in males (vs. grey in *C. obscurus*); white dot on centre of each scale of flank (vs. restricted to middle portion of flank in *C. obscurus*); and ventral process of autopalatine present (vs. absent in *C. obscurus*).

Description. Morphometric data as in Table 2. Largest male examined 46.6 mm SL; largest female examined 52.3 mm SL. Dorsal and ventral profiles slightly convex between snout and end of dorsal and anal fin bases, barely concave at caudal peduncle, dorsal and ventral profiles diverging posteriorly. Body moderately slender; greatest body depth at level of pectoral-fin base. Uro-



genital papilla cylindrical in males, short, about as long as wide; urogenital opening of females situated in pocket-like structure, overlapping anal-fin origin. Longitudinal series of scales 34–39; transverse series of scales 12–14; scale rows around caudal peduncle 22–24. Contact organ on scales absent. One neuromast on each scale of lateral line. Total vertebrae 34–35.

Eye positioned dorsolaterally on head. Snout short, blunt. Premaxillary and dentary teeth conical, small, numerous; irregularly arranged, except for external series with large fang-like teeth, slightly curved inside mouth. Vomerine teeth absent. Dermosphenotic absent. Scales small, irregularly arranged on frontal region. Cephalic neuromasts: supraorbital 29–30, parietal 5, preopercular plus mandibular 53–60; anterior rostral 3, posterior rostral 4, infraorbital 3+29–37, preorbital 2–4, otic 5–7, post-otic 6, supratemporal 3, median opercular 3–4, ventral opercular 4, lateral mandibular 13–16, paramandibular 1. Gill rakers on first branchial arch 3+9; gill rakers about triangular, about straight, length about thrice width, in close proximity, with denticles. Six branchiostegal rays. Basihyal sub-triangular, width 70 % of length in male, about 65 % in females; basihyal cartilage short, about 15–20 % of total length of basihyal. Autopalatine narrow, ventral process present.

Dorsal and anal fins sub-triangular in males, posterior extremity gently pointed; short filamentous rays on tip of dorsal, projecting slightly beyond fin membrane, long filamentous rays on tip of anal fin, tip reaching vertical through middle of caudal fin. Dorsal fin slightly pointed, anal fin rounded in females, without filamentous rays; distal portion of anterior anal-fin rays strongly thickened. Few scales extending over dorsal-fin, short transverse scale rows slightly extending on middle of anal-fin base, between fin rays, in both sexes. Caudal fin rounded; scales extending for about basal 30 % of caudal fin. Two neuromasts on caudal-fin base. Pectoral fin elliptical, posterior margin reaching vertical between base of sixth and seventh anal-fin rays in males, reaching urogenital papilla in females. Scales on pectoral-fin base absent. Ventral process of posttemporal absent. Pelvic-fin tip reaching between base of second and third anal-fin rays in males, and base of first anal-fin ray in females. Pelvic-fin bases medially separated by interspace. Dorsal-fin origin at vertical between base of sixth and seventh anal-fin rays in males, and base of fourth ray in females. Dorsal-fin origin between neural spines of vertebrae 14 and 15 in males, and vertebrae 16 and 17 in females; anal-fin origin between pleural ribs of vertebrae 12 and 13. Dorsal-fin rays 17–20

Table 2. Morphometric data of *Cynolebias roseus* and *C. rectiventer*.

	<i>C. roseus</i>			<i>C. rectiventer</i>		
	holotype	paratypes		holotype	paratypes	
	male	males (2)	females (2)	male	males (7)	females (6)
Standard length (mm)	46.6	43.2–44.5	51.6–52.3	78.3	72.5–101.8	52.2–81.2
Percent of standard length						
Body depth	32.9	33.7–34.1	34.1–35.6	32.0	29.1–33.5	30.7–32.5
Caudal peduncle depth	16.5	17.6–17.7	16.6–18.4	16.0	14.8–16.2	14.7–15.2
Pre-dorsal length	63.1	62.6–65.8	68.6–70.1	62.5	59.1–64.3	64.9–67.5
Pre-pelvic length	52.6	51.7–51.7	58.0–59.8	50.5	49.5–53.6	53.8–57.7
Length of dorsal-fin base	27.8	26.1–27.9	23.5–27.1	25.2	25.3–28.0	22.1–23.0
Length of anal-fin base	36.3	34.5–37.2	26.6–26.8	30.5	29.3–33.9	23.6–26.5
Caudal-fin length	37.7	37.2–40.9	32.6–34.6	32.5	27.5–31.4	30.2–33.0
Pectoral-fin length	28.3	27.9–30.6	27.8–29.4	25.2	24.1–27.1	24.1–26.6
Pelvic-fin length	9.2	8.4–8.5	8.6–9.0	8.3	6.7–8.2	8.2–8.6
Head length	32.9	33.3–34.0	35.9–36.0	34.4	30.0–33.8	32.2–33.9
Percent of head length						
Head depth	98	94–97	89–92	92	90–102	85–95
Head width	75	73–76	74–75	74	69–78	69–77
Snout length	13	13–13	12–13	13	14–15	12–15
Lower jaw length	26	24–26	24	28	25–30	22–27
Eye diameter	26	24–27	22–23	18	17–20	19–22



in males, 16–17 in females; anal-fin rays 20–23 in males, 19 in females; caudal-fin rays 30–31; pectoral-fin rays 14; pelvic-fin rays 6. Minute papillate contact organs on inner surface of all pectoral-fin rays in males.

Colouration. Males: Lateral and dorsal surfaces of body pale golden to light pink, with horizontal rows of white dots. Round pale grey blotch on humeral region. Venter yellowish white. Lateral surfaces of head pale blue; reddish brown pigmentation concentrated on posterior supraorbital, ventral infraorbital, parietal, otic and post-otic series of neuromasts. Iris light yellow, with blue iridescence and dark reddish brown bar. Unpaired fins dark yellow ochre with bluish white dots; distal portion of anal fin red with light blue lines between fin rays, filaments black; distal portion of caudal fin light bluish grey. Pectoral fin hyaline. Pelvic fin yellowish orange.

Females: Dorsal and lateral surfaces of body pale pink; black spot on anteromedial portion of flank in smaller individuals (below 50 mm SL). Venter pinkish white. Lateral surfaces of head pale blue; faint brown pigmentation concentrated on posterior supraorbital, ventral infraorbital, parietal, otic and post-otic series of neuromasts. Iris light yellow, with dark reddish brown bar. Fins hyaline.

Etymology. From the Latin *roseus* (pink), in reference to the main colour of this species. An adjective.

Distribution, habitat and conservation. Known from a single locality near the town of Barra, in the left-bank floodplain of the São Francisco river. The biotope was a remnant temporary pool, in an area occupied by cattle farms and plantations. Although the neighbouring region to north, between Barra and the village of Ibiraba, is well preserved, with numerous seasonally flooded areas, this species was not found there. However, the possibility of its occurrence in poorly accessible areas of this region cannot be excluded, making its present conservation status still undetermined.

Cynolebias rectiventer, new species (Fig. 4)

Holotype. UFRJ 8896, male, 78.3 mm SL; Brazil: Estado da Bahia: Município de Itaguaçu da Bahia: seasonal lagoon in the floodplains of the Verde river, a right tributary of the middle São Francisco river, about 30 km N of the town of Itaguaçu, 10°43'20" S 42°20'30" W, altitude 414 m asl; W. J. E. M. Costa et al., 8 May 2010.

Paratypes. UFRJ 6850, 7 males, 57.6–101.8 mm SL, 11 females, 46.9–81.2 mm SL; ZFMK 56333–34, 1 male, 79.6 mm SL, 1 female, 52.9 mm SL; BMNH 2013.6.23.7–8, 1 male, 73.1 mm SL, 1 female, 49.4 mm SL; UFRJ 6851, 1 male, 74.2 mm SL, 2 females, 52.2–59.5 mm SL; UFRJ 8898, 2 males, 66.7–68.6 mm SL, 3 females, 49.9–56.7 mm SL (c&s); UFRJ 6826, 1 male, 42.3 mm SL, 7 females, 43.5–71.6 mm SL; collected with holotype.

Diagnosis. *Cynolebias rectiventer* is distinguished from all other congeners of the *C. perforatus* group by the presence of contact organs restricted to the seven uppermost rays of the pectoral fin in males (vs. contact organs on all rays), presence of a ventral process on the autopalatine (vs. absence); scales absent on the dorsal-fin base (vs. present); gill rakers slightly curved (vs. bowed), denticles restricted to the gill-raker margin (vs. on the entire surface); less than one third of caudal fin anteriorly covered by scales (vs. more than one third). *Cynolebias rectiventer* is also distinguished from all congeners by having the lateral profile of the abdominal region approximately straight in males (vs. convex).

Description. Morphometric data as in Table 2. Largest male examined 101.8 mm SL; largest female examined 81.2 mm SL. Dorsal profile straight and evenly sloping at head, abruptly convex at nape, approximately straight and horizontal at predorsal region and at caudal peduncle. Ventral profile nearly straight in males, slightly convex in females from lower jaw to end of anal-fin base, approximately straight at caudal peduncle. Body moderately deep, robust; greatest body depth at level of pectoral-fin base. Urogenital papilla cylindrical in males, short, about as long as wide; urogenital opening of females situated in pocket-like structure, slightly overlapping anal-fin origin. Longitudinal series of scales 38–46; transverse series of scales 18–21; scale rows around caudal



Fig. 4. *Cynolebias rectiventer*, UFRJ 8896, holotype, male, 78.3 mm SL; Brazil: Bahia: Itaguaçu.

peduncle 26–28. One neuromast on each scale of lateral line. Contact organ on scales absent. Total vertebrae 35–37.

Eye positioned dorsolaterally on head. Snout short, subtriangular in lateral view. Premaxilla and dentary teeth conical, small, numerous; irregularly arranged, except for external series with large fang-like teeth, slightly curved inside mouth. Vomerine teeth absent. Dermosphenotic absent. Scales small, irregularly arranged on frontal region. Cephalic neuromasts: supraorbital 29–36, parietal 3–5, pre-opercular plus mandibular 56–60, anterior rostral 3–4, posterior rostral 3–5, infraorbital 5–6+30–38, preorbital 3–4, otic 8–11, post-otic 5–7, supratemporal 3–4, median opercular 3–4, ventral opercular 4–5, lateral mandibular 13–15, paramandibular 1. Gill rakers on first branchial arch 3+10; gill rakers of first ceratobranchial sub-triangular, broad, separated by small interspace, with denticles along margin. Six branchiostegal rays. Basihyal sub-triangular, width about 65 % of length in both sexes; basihyal cartilage short, about 25 % of total length of basihyal. Ventral process of autopalatine present.

Dorsal fin sub-triangular in both sexes, posterior extremity gently pointed; short filamentous rays on tip of fin in males, slightly projecting beyond fin membrane; scales on dorsal-fin base absent. Anal fin sub-triangular in males, posterior extremity weakly pointed, with six filamen-

tous rays of variable length, reaching vertical between caudal-fin base and caudal-fin posterior margin; anal fin semi-circular in females, distal portion of anterior rays strongly thickened; short transverse scale rows at middle of anal-fin base between fin rays, in both sexes. Caudal fin rounded; scales extending for about basal 30 % of caudal fin. Two neuromasts on caudal-fin base. Pectoral fin long, elliptical, posterior margin reaching vertical between base of third and fourth anal-fin rays in males, reaching anus in females; few scales irregularly arranged on pectoral-fin base. Ventral process of posttemporal absent. Pelvic fin short, tip reaching base of first or second anal-fin ray. Pelvic-fin bases medially separated by interspace. Dorsal-fin origin at vertical between base of fifth and sixth anal-fin rays. Dorsal-fin origin between neural spines of vertebrae 15 and 18; anal-fin origin between pleural ribs of vertebrae 14 and 16. Dorsal-fin rays 17–20 in males, 15–17 in females; anal-fin rays 19–21 in males, 18–21 in females; caudal-fin rays 31–34; pectoral-fin rays 14; pelvic-fin rays 6. Minute papillate contact organs on seven dorsalmost rays of pectoral fin in males.

Colouration. Males: Lateral surfaces of body light golden with light blue to white dots; 18–20 pale grey bars barely visible only in preserved specimens. Dorsum pale golden, venter yellowish



Fig. 5. *Cynolebias parietalis*, UFRJ 9449, holotype, male, 74.0 mm SL; Brazil: Minas Gerais: Monte Azul.

white. Lateral surfaces of head pale blue; reddish brown pigmentation concentrated on posterior supraorbital, parietal and otic series of neuromasts. Iris light pale yellow, with orangish brown bar. Unpaired fins light bluish grey, with white dots; distal portion of anal fin pale pink, filaments dark grey to black. Pectoral fin hyaline. Pelvic fin light bluish grey.

Females: Lateral surfaces of body pale silver; one or two black spots on anteromedial portion of flank present in some individuals; 16–19 pale grey bars barely visible, only prominent in preserved specimens. Venter white. Opercular region pale silver. Iris light yellow, with grey bar. Fins hyaline; faint white dots on unpaired fins.

Etymology. From the Latin *rectus* (straight) and *venter* (belly) referring to the straight ventral profile of the body in males, a condition unique in *Cynolebias*. A noun in apposition.

Distribution, habitat and conservation. *Cynolebias rectiventer* is known only from two geographically proximate temporary lagoons occupying an area of about 5 km², within a small farm for cattle breeding. The lagoons were shallow, about 1.0 m deep, with sparse aquatic vegetation. The fish were abundant and collected close to the lagoon bottom. The area is situated in the floodplain of a seasonal tributary to the Verde river,

about 3 km distant from that tributary and about 18 km W from the Verde river, which is a right-bank tributary of the lower-middle São Francisco river basin in the Bahia state. This area is situated in a well-conserved region, with many other similar swampy areas awaiting sampling. It is likely not to be a threatened species.

Cynolebias parietalis, new species
(Fig. 5)

Holotype. UFRJ 9449, male, 74.0 mm SL; Brazil: Estado de Minas Gerais: Município de Monte Azul: temporary pool about 1 km E of the village of Gado Bravo, road Matias Cardoso-Espinosa, Verde Grande river floodplains, São Francisco river basin, 14°55'16" S 43°29'31" W, altitude 450 m asl; W. J. E. M. Costa et al., 10 Feb. 1999.

Paratypes. All from Verde Grande river floodplains, UFRJ 4777, 2 males, 74.0–76.5 mm SL, 3 females, 59.8–63.9 mm SL; collected with holotype. – UFRJ 9445, 4 males, 60.5–68.9 mm SL; ZFMK 56329–30, 1 male, 70.9 mm SL, 1 female, 56.5 mm SL; BMNH 2013.6.23.5–6, 1 male, 62.2 mm SL, 1 female, 52.5 mm SL; UFRJ 4776, 5 males, 60.3–68.2 mm SL, 3 females, 46.5–50.3 mm SL; temporary pool 2 km W of Gado Bravo, 14°55'29" S 43°31'26" W, altitude 450 m; W. J. E. M.



Costa et al., 10 Feb. 1999. – UFRJ 6719, 1 male, 45.0 mm SL, 2 females, 32.9–38.9 mm SL; UFRJ 9450, 2 females, 50.2–53.1 mm SL; right bank floodplains of Verde Grande river, 14°55.333' S 43°29.925' W, altitude 450 m; W. J. E. M. Costa et al., 6 May 2009.

Additional material (non-types). UFRJ 4774, 29; UFRJ 4775, 22; same data as UFRJ 9445. – UFRJ 9446, 5; same data as UFRJ 6719.

Diagnosis. *Cynolebias parietalis* is distinguished from all congeners of the *C. perforatus* group by having supraorbital and parietal series of neuromasts united (vs. separate) and basihyal width about 70–75 % of basihyal length (vs. about 50–65 %). It is further distinguished from all congeners of the *C. perforatus* group, except *C. perforatus*, by having 33–35 caudal-fin rays (vs. 28–32).

Description. Morphometric data as in Table 3. Largest male examined 76.5 mm SL; largest female examined 63.9 mm SL. Dorsal profile evenly sloping and nearly straight at head, convex at nape, approximately straight between nape and caudal peduncle. Ventral profile convex from lower jaw to end of anal-fin base, approximately straight at caudal peduncle. Body moderately deep, robust; greatest body depth at level of pectoral-fin base.

Urogenital papilla cylindrical in males, short, about as long as wide; urogenital opening of females situated in pocket-like structure, overlapping anal-fin origin. Longitudinal series of scales 38–41; transverse series of scales 15–16; scale rows around caudal peduncle 24–26. One neuromast on each scale of lateral line. Contact organ on scales absent. Total vertebrae 35–37.

Eye positioned dorsolaterally on head. Snout short, subtriangular in lateral view. Premaxillary and dentary teeth conical, small, numerous; irregularly arranged, except for external series with large fang-like teeth, slightly curved inside mouth. One vomerine tooth, absent in some individuals. Dermosphenotic absent. Scales small, irregularly arranged on frontal region. Cephalic neuromasts: supraorbital plus parietal 34–43, pre-opercular plus mandibular 62–70; anterior rostral 3, posterior rostral 3–4, infraorbital 3–5 + 33–39, preorbital 2–3, otic 5–9, post-otic 6–8, supratemporal 3–4, median opercular 1–2, ventral opercular 4–5, lateral mandibular 12–14, paramandibular 1. Gill rakers on first branchial arch 3 + 10–11, gill rakers bowed, entire surface covered by denticles. Six branchiostegal rays. Basihyal sub-triangular, width about 70–75 % of length in both sexes; basihyal cartilage short, about 20 % of total length of basihyal. Autopalatine narrow, ventral process absent.

Table 3. Morphometric data of *Cynolebias parietalis* and *C. oticus*.

	<i>C. parietalis</i>			<i>C. oticus</i>		
	holotype	paratypes		holotype	paratypes	
	male	males (7)	females (7)	male	males (5)	females (8)
Standard length (mm)	74.0	62.5–76.5	50.2–63.9	82.3	57.2–73.5	48.6–70.7
Percent of standard length						
Body depth	34.8	30.4–35.7	31.1–36.1	30.4	29.2–30.2	27.8–31.2
Caudal peduncle depth	15.7	14.1–16.9	13.7–15.9	14.0	13.4–14.5	13.0–14.8
Pre-dorsal length	62.5	61.8–64.8	64.0–68.7	61.7	62.8–64.7	63.9–67.8
Pre-pelvic length	53.0	50.8–53.8	54.8–58.6	53.0	52.1–57.1	54.2–56.1
Length of dorsal-fin base	27.4	25.5–27.0	23.4–25.0	27.6	22.8–26.3	20.6–22.6
Length of anal-fin base	34.0	29.1–32.4	23.1–25.9	29.1	27.9–29.1	22.8–25.3
Caudal-fin length	37.8	28.5–33.4	28.7–32.4	29.8	30.9–33.1	30.1–33.1
Pectoral-fin length	25.8	23.3–27.3	22.0–25.8	22.4	22.7–25.2	23.1–26.7
Pelvic-fin length	9.2	7.9–9.2	8.4–10.7	7.3	7.6–9.0	8.0–9.2
Head length	35.0	33.3–35.5	35.1–36.0	33.9	34.6–35.4	31.8–35.0
Percent of head length						
Head depth	98	86–98	88–94	91	83–87	83–89
Head width	73	70–76	70–77	73	70–77	70–79
Snout length	16	14–16	12–15	14	13–15	14–15
Lower jaw length	30	28–30	23–26	29	27–30	24–29
Eye diameter	20	21–25	22–25	18	18–21	19–23



Dorsal and anal fins sub-triangular in males, posterior extremity gently pointed; filamentous rays on tip of dorsal fin absent; long filamentous rays on tip of anal fin, reaching to posterior portion of caudal fin; dorsal and anal fins rounded in females, without filamentous rays, distal portion of anterior anal-fin rays strongly thickened. Scales on dorsal-fin base absent; transverse scale rows on anal-fin base situated between fin rays in both sexes. Caudal fin rounded; scales extending to about basal 35–40 % of caudal fin. Two neuromasts on caudal-fin base. Pectoral fin elliptical, posterior margin reaching vertical through base of 4th anal-fin ray, reaching anus in females; scales on pectoral-fin base. Ventral process of posttemporal absent. Pelvic-fin tip reaching between base of second and third anal-fin rays. Pelvic-fin bases medially separated by interspace. Dorsal-fin origin at vertical between base of fifth or fourth anal-fin ray. Dorsal-fin origin between neural spines of vertebrae 14 and 16; anal-fin origin between pleural ribs of vertebrae 13 and 15. Dorsal-fin rays 16–19 in both sexes; anal-fin rays 20–22 in males, 19–21 in females; caudal-fin rays 33–35; pectoral-fin rays 14–15; pelvic-fin rays 6. Minute papillate contact organs on inner surface of all pectoral-fin rays in males.

Colouration. Males: Lateral surfaces of body yellowish brown, with horizontal rows of light blue dots. Grey blotch on humeral region. Dorsum yellowish brown, venter yellowish white. Lateral surfaces of head pale blue on suborbital region, yellowish brown in dorsal and mandibular region, pale golden on opercle; reddish brown pigmentation concentrated on posterior supraorbital, ventral infraorbital, parietal, otic and post-otic series of neuromasts. Iris light pinkish orange, with dark brown bar. Unpaired fins grey with bluish white dots; distal portion of anal fin pale pink with pale blue iridescence, filaments black; distal portion of caudal fin light bluish grey. Pectoral fin hyaline. Pelvic fin yellowish brown. Females: Similar to males, but without horizontal rows of light blue dots and with unpaired fins hyaline.

Etymology. From the Latin *parietalis* (relative to wall), an allusion to the morphology of the parietal neuromast series, which is united to the posterior portion of the supraorbital series, a diagnostic condition for this species. An adjective.

Distribution, habitat and conservation. Known from temporary pools in the floodplains of both banks of the Verde Grande river, close to the village of Gado Bravo. As a result of recent urban expansion, pools in the left bank sampled in 1999 were no longer present in 2009, when a considerable expansion of agricultural fields in the whole area was noticed (Costa et al., 2012). Other areas within the floodplains of the Verde Grande river still unsampled for killifishes are covered by native vegetation, but additional field inventories are needed to ascertain the occurrence of this species there, making its conservation status presently undetermined.

Cynolebias oticus, new species

(Fig. 6)

Holotype. UFRJ 9437, male, 82.3 mm SL; Brazil: Estado da Bahia: Município de Pindaí: temporary pool close to road BR-122, about 8 km S of village of Pindaí, Mata Veado creek floodplains, Verde river drainage, São Francisco river basin, 14°33' 39" S 42°42'10" W, altitude 628 m asl; W. J. E. M. Costa and C. P. Bove, 15 Jan. 2005.

Paratypes. All from Município de Pindaí, Estado da Bahia, Brazil. UFRJ 9353, 1 male, 73.5 mm SL, 1 female, 69.4 mm SL; UFRJ 9354, 1 male, 58.1 mm SL, 4 females, 45.5–54.8 mm SL (c&s); UFRJ 9355, 2 males, 58.7–63.0 mm SL, 15 females, 40.7–70.7 mm SL; BMNH 2013.6.23.3-4, 1 male, 49.3 mm SL, 1 female, 61.7 mm SL; SMF 34896, 1 male, 64.0 mm SL, 1 female, 50.8 mm SL; ZFMK 56327-28, 1 male, 57.2 mm SL, 1 female, 54.2 mm SL; collected with holotype. – UFRJ 6809, 2 males, 46.6–50.4 mm SL, and 3 females, 39.4–43.0 mm SL; UFRJ 6812, 5 females, 34.1–42.1 mm SL; same locality; W. J. E. M. Costa et al., 29 Jan. 2010. – UFRJ 6723, 1 male, 31.8 mm SL, 8 females, 29.1–35.0 mm SL; about 20 km S of Pindaí, 14°40.150' S 42°41.001' W; W. J. E. M. Costa et al., 7 May 2009.

Additional material (non-types). UFRJ 9352, male, 81.0 mm SL; UFRJ 6815, 1 female, 66.8 mm SL; UFRJ 6802, 2 females, 57.0–63.0 mm SL; Brazil: Estado da Bahia: Município de Pindaí: temporary pool close to road BR-122, about 12 km S of village of Pindaí, 14°33'40" S 42°42'09" W, altitude 614 m asl; W. J. E. M. Costa et al., 29 Jan. 2010. – UFRJ 9438, 28; same data as holotype.



Fig. 6. *Cynolebias oticus*, UFRJ 9437, holotype, male, 82.3 mm SL; Brazil: Bahia: Pindaí.

Diagnosis. *Cynolebias oticus* is distinguished from all congeners of the *C. perforatus* species group by having the otic and post-otic series of neuromasts often united, in close proximity when not united (separated by interspace) and dorsal profile of the head always concave (vs. not concave at least in larger males above 70 mm SL).

Description. Morphometric data as in Table 3. Largest male examined 82.3 mm SL; largest female examined 70.7 mm SL. Dorsal profile concave to nearly straight and evenly sloping at head, convex at nape, approximately straight and horizontal at pre-dorsal region and at caudal peduncle. Ventral profile convex from lower jaw to end of anal-fin base, approximately straight at caudal peduncle. Body moderately deep, robust, greatest body depth at level of pectoral-fin base. Urogenital papilla cylindrical in males, short, about as long as wide; urogenital opening of females situated in pocket-like structure, overlapping anal-fin origin. Longitudinal series of scales 37–44; transverse series of scales 17–18; scale rows around caudal peduncle 26–30. One neuromast on each scale of lateral line. Contact organ on scales absent. Total vertebrae 35–36.

Eye positioned dorsolaterally on head. Snout short, subtriangular in lateral view. Premaxillary and dentary teeth conical, small, numerous; irregularly arranged, except for external series with large fang-like teeth, slightly curved inside mouth.

One vomerine tooth, absent in some individuals. Dermosphenotic absent. Scales small, irregularly arranged on frontal region. Cephalic neuromasts: supraorbital 33–37, parietal 4–5, pre-opercular plus mandibular 65–84; anterior rostral 2–3, posterior rostral 4–5, infraorbital 3–4 + 35–44, preorbital 2–4, otic plus post-otic 17–25, supratemporal 3–4, median opercular 1, ventral opercular 2–4, lateral mandibular 9–12, paramandibular 1. Gill rakers on first branchial arch 3 + 10–11, gill rakers bowed, entire surface covered by denticles. Six branchiostegal rays. Basihyal sub-triangular, width about 65–70 % of length in both sexes; basihyal cartilage short, about 25–30 % of total length of basihyal. Autopalatine narrow, ventral process absent.

Dorsal and anal fins sub-triangular in males, posterior extremity gently pointed; short filamentous rays on tips of dorsal and anal fins, projecting slightly beyond fin membrane; dorsal and anal fins rounded in females, without filamentous rays; distal portion of anterior anal-fin rays strongly thickened. Scales on dorsal-fin base absent; transverse scale rows on anal-fin base between fin rays, in both sexes. Caudal fin rounded; scales extending for about basal 35–40 % of caudal fin. Two neuromasts on caudal-fin base. Pectoral fin elliptical, posterior margin reaching vertical between urogenital papilla and base of second anal-fin ray in males, between pelvic-fin insertion and urogenital papilla in females; few



Fig. 7. *Cynolebias porosus*, UFRJ 6824, male, 59.1 mm SL; Brazil: Pernambuco: Santa Maria da Boa Vista.

scales irregularly arranged on pectoral-fin base. Ventral process of posttemporal absent. Pelvic-fin tip reaching between base of first and third anal-fin rays. Pelvic-fin bases medially separated by interspace. Dorsal-fin origin at vertical between base of fourth and sixth anal-fin rays. Dorsal-fin origin between neural spines of vertebrae 15 and 18; anal-fin origin between pleural ribs of vertebrae 13 and 14. Dorsal-fin rays 16–18 in males, 15–17 in females; anal-fin rays 19–21 in males, 18–21 in females; caudal-fin rays 29–32; pectoral-fin rays 14–15; pelvic-fin rays 6. Minute papillate contact organs on inner surface of all pectoral-fin rays in males.

Colouration. Males: Lateral surfaces of body with 17–19 yellowish brown bars separated by narrow dark golden interspaces, and horizontal rows of light blue dots. Three or four dark brown blotches on humeral region. Dorsum yellow ochre, venter yellowish white. Lateral surfaces of head pale purplish blue on suborbital region, yellow ochre in dorsal and mandibular region, pale golden on opercle; reddish brown pigmentation concentrated on posterior supraorbital, ventral infraorbital, parietal, otic and post-otic series of neuromasts. Iris light pinkish orange, with dark brown bar. Unpaired fins greenish yellow ochre with bluish white dots; distal portion of anal fin pale pink with pale blue iridescence, fin tip black; distal portion of caudal fin light bluish grey.

Pectoral fin hyaline. Pelvic fin yellowish orange.

Females: Similar to males, but without horizontal rows of light blue dots; with horizontal row of two or three black spots on anteromedial portion of flank, often absent in larger females (above 55 mm SL). Unpaired fins hyaline with pale dark ochre spots and sparse blue iridescence.

Etymology. From the Greek *oticus* (relative to ear), referring to the continuous otic and post-otic series of neuromasts, which is diagnostic for this species. An adjective.

Distribution, habitat and conservation. *Cynolebias oticus* is known only from the Verde river drainage, near the village of Pindaí. Although the region has been highly deforested in recent years, leading to the extirpation of some seasonal killifishes formerly inhabiting the area (*C. gilbertoi*, *C. leptocephalus*, *Hypsolebias fulminantis*), *C. oticus* can still be easily found here. However, the current reduced area of occupancy suggests that *C. oticus* could be a vulnerable species.

Cynolebias porosus Steindachner, 1876
(Fig. 7)

Cynolebias porosus Steindachner, 1876: 173, pl. 3 fig. 4). Holotype: NMW 15096, male, 76.2 mm TL. Type locality: Pernambuco, Brazil.



Cynolebias albipunctatus Costa & Brasil, 1991: 58, fig. 3. Holotype: MZUSP 41378, male, 97.4 mm SL. Type locality: county of Juazeiro, 70 km S from Uauá [road BR-235, between Juazeiro and Uauá, about 70 km NW of village of Uauá, 9°32'45"S 39°58'48" W, altitude 440 m], Estado da Bahia, Brazil. New synonym.

Material examined. All localities in the São Francisco river basin, Brazil. Estado de Pernambuco: NMW 15096, holotype; Pernambuco; unknown collector (only photographs examined). – UFRJ 1769, 8; UFRJ 4515, 1 (c&s); Pernambuco: temporary pool near Lagoa Grande, Município de Santa Maria da Boa Vista, 9°00'14"S 40°16'49" W, altitude 366 m asl; G. C. Brasil & S. C. Alencar, 16 May 1989. – UFRJ 6824, 8; UFRJ 6823, 10; UFRJ 7862, 2 (c&s); temporary pool, Estrada do Vinho, Santa Maria da Boa Vista, 8°52'11"S 39°55'25" W, altitude 361 m asl; W. J. E. M. Costa et al., 11 May 2010.

Estado da Bahia: MZUSP 41378, holotype of *C. albipunctatus*; MZUSP 41379, 9 paratypes of *C. albipunctatus*; UFRJ 160, 24; ZFMK 56335-36, 2; UFRJ 4467, 6 (c&s); about 70 km NW of Uauá, 9°32'45"S 39°58'48" W; G. C. Brasil & S. C. Alencar, 17 May 1989. – UFRJ 1768, 18; temporary pool, Município de Juazeiro, 9°27'32"S 40°25'27" W, altitude 374 m asl; G. C. Brasil & S. C. Alencar, 17 May 1989. – UFRJ 5129, 1; UFRJ 5273, 2; temporary pool near Juazeiro, 9°25'24"S 40°26'20" W, altitude 366 m asl; W. J. E. M. Costa et al., 19 May 2000. – UFRJ 5127, 3; UFRJ 5128, 1 (c&s); temporary pool close to Manicóba, Juazeiro, 9°10'13"S 40°16'39" W, altitude 360 m asl; W. J. E. M. Costa et al., 19 May 2000. – UFRJ 9342, 8 ex.; temporary pool, road BA-210, Abaré, 8°36'58"S 39°27'48" W, altitude 380 m asl; W. Severi et al., 10 March 2009.

Diagnosis. *Cynolebias porosus* is distinguished from all congeners by having the upper jaw ventrally displaced.

Distribution, habitat and conservation. *Cynolebias porosus* is endemic to the São Francisco river floodplain between the city of Petrolina and village of Ibaré. The natural environment of this area was, for the most part, substituted by grape plantations after the region became an important centre of wine production. The natural vegetation and seasonal swamps have almost disappeared in the area along the floodplain of the left bank of the São Francisco river. This area is presently occupied by farms; consequently, this species is considered critically endangered due to the sharp decline of habitats. However, the conservation status of populations found in poorly accessible areas along the right-bank floodplain of the São Francisco river is still undetermined.

Remarks. Costa (2001) considered *C. porosus* and *C. albipunctatus* as distinct species, the former known only from the holotype collected in "Pernambuco", and the latter endemic to the São Francisco basin. *Cynolebias albipunctatus* was mainly distinguished from *C. porosus* by the former lacking scales on the anal fin, whereas the only known specimen of the latter has scales extending slightly over the middle of the anal-fin base. Material recently collected near Santa Maria da Boa Vista, Pernambuco, revealed that both morphological conditions are present in this population, besides agreeing well with the other characters described by Steindachner. Costa (2001) suspected that the type specimen was collected near the coastal city of Recife, but after some decades studying *Cynolebias*, species of this group have been broadly recorded only for the savannahs distant from the coast, never in the coastal Atlantic forest area. However, although that part of the Caatinga was poorly known to naturalists at the time of Steindachner's description, studies indicate that a seasonal fish of the genus *Cynolebias* from the São Francisco river basin in Pernambuco state was already known among local naturalists during the second half of the 19th century, who frequently were in contact and sent study material to European naturalists (e.g. Rosado & Silva, 2001). Consequently, *C. porosus* is considered endemic to the São Francisco river basin in Pernambuco state and an adjacent part of Bahia state, whereas *C. albipunctatus* is herein placed in the synonymy of *C. porosus*.

The publication date of the original description by Steindachner has variably appeared as 1876 or 1877 on fish taxonomy websites. This confusion is probably derived from both years appearing in different parts of the volume in which the paper was published. However, as demonstrated by Kottelat (2013), that issue was published on 9 November 1876.

Discussion

Among the new species, two (*C. ochraceus* and *C. parietalis*) had been misidentified in the past (Costa, 2001) due to the overall similarity with *C. gilbertoi* and *C. perforatus*, respectively. The other four new species (*C. obscurus*, *C. oticus*, *C. rectioenter* and *C. roseus*) were unknown at the time of previous studies. The use of larger samples, including material from the several popula-



tions along the São Francisco river basin now available, provided clearer information about morphological variability, making possible to delineate species limits more consistently.

This study also documents rapid deforestation in the São Francisco basin threatening species of *Cynolebias*, similar to that recently reported for species of the seasonal killifish genus *Hypsolebias* endemic to the same region (Costa et al., 2012). After a first conservation assessment in 2002, when a slight decline in killifish populations from the Caatinga was reported (Costa, 2002), a broad loss of killifish habitats that puts the survival of killifish species at risk has been documented (Costa et al., 2012). As described above, at least *C. ochraceus* and *C. obscurus* are endangered, whereas the conservation status of *C. parietalis* and *C. roseus* is still undetermined as a result of insufficient field data.

Acknowledgements

Thanks are due C. P. Bove, B. B. Costa, M. A. Barbosa, J. C. Gomes, G. J. Silva, O. C. Simões, A. Oliveira, L. Alexandre, F. Pupo, and E. Araujo for help during collecting trips; to T. Alpermann, F. Herder, J. Maclaine, C. Mello, O. Oyakawa, G. J. Silva, and O. C. Simões, for curatorial support; to M. Kottelat for providing suggestions and corrections on the text; to W. Severi for sending material; and to H. Wellendorf for sending a photograph of the type specimen of *C. porosus*. Previous versions of this manuscript benefited from the comments provided by anonymous reviewers. This study was funded by FAPERJ (Fundação de Amparo à Pesquisa do Estado do Rio de Janeiro) and CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico – Ministério de Ciência e Tecnologia). Collections were made with licenses provided by IBAMA (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis) and ICMBio (Instituto Chico Mendes de Conservação da Biodiversidade).

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Received 25 July 2013

Revised 4 April 2014

Accepted 3 June 2014

Ichthyological Exploration of Freshwaters

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Cover photograph

Parananochromis orsorum, female (photograph by A. Lamboj)

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