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# Ichthyological Exploration of Freshwaters

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## *Hypsolebias nudiorbitatus*, a new seasonal killifish from the Caatinga of northeastern Brazil, Itapicuru River basin (Cyprinodontiformes: Rivulidae)

Wilson J. E. M. Costa\*

*Hypsolebias nudiorbitatus*, new species, is described from the semi-arid Caatinga area of northeastern Brazil, upper Itapicuru River basin. It is a member of the *H. antenori* species group, differing from all other species of this group by having a rudimentary squamation on the supra-orbital region, a unique color pattern on the caudal fin in males consisting of white dots arranged in transverse rows, 14 scale rows around the caudal peduncle, the dorsal fin slightly more posteriorly placed in males and the basihyal bone narrow.

*Hypsolebias nudiorbitatus*, sp. nov., é descrita da área semi-árida da Caatinga do nordeste do Brasil, bacia do alto rio Itapicuru. Ela é um membro do grupo de espécies *H. antenori*, diferindo de todas as outras espécies deste grupo por possuir uma escamação rudimentar na região supra-orbital, um padrão de colorido exclusivo em machos consistindo de pontos brancos dispostos em fileiras transversais, 14 fileiras de escamas em torno do pedúnculo caudal, nadadeira dorsal posicionada um pouco mais posteriormente em machos e osso basial estreito.

### Introduction

*Hypsolebias* was first described as a subgenus of *Simpsonichthys* (Costa, 2006a), but following the results of a recent phylogenetic analysis of cynolebiasines, in which the clade containing all species of *Hypsolebias* was hypothesized to be more closely related to species of the genera *Spectroblebias*, *Cynolebias* and *Austrolebias* than to *Simpsonichthys*, *Hypsolebias* is presently considered to be a distinct genus (Costa, 2010a). Species of *Hypsolebias* were revised by Costa (2007), who recognized 33 valid species from an area encompassing central and northeastern Brazil, in the upper and

middle sections of the Tocantins River, middle section of the São Francisco River basin, and smaller coastal river basins draining into the northern Brazilian coast. Subsequently, three other species were first described: *H. longignatus* from the Pacoti River drainage (Costa, 2008) and *H. harmonicus* and *H. lopesi* from the middle São Francisco River basin (Costa, 2010b; Nielsen et al., 2010).

Among species of *Hypsolebias*, a clade known as the *H. antenori* species group has been well supported in phylogenetic studies; it is diagnosed by the presence of numerous (6–10) pharyngobranchial teeth (vs. 1–4), anteromedian flap of

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preopercle rudimentary or absent (vs. well-developed), and black spots arranged on the whole caudal peduncle side in females (vs. never a similar color pattern) (Costa, 2003; 2006a; 2010a). It comprises eight species: *H. flagellatus*, *H. flavicaudatus*, *H. ghisolfii*, *H. igneus*, *H. janaubensis*, *H. macaubensis* and *H. mediopapillatus* from the São Francisco River basin, and *H. antenori* from small river basins draining into the northern Brazilian coast (Costa & Brasil, 1990; Costa et al., 1996; Costa, 2006b). The present paper deals with the description of a new species of the *H. antenori* group collected in the upper Itapicuru River basin, constituting the first record of the genus for that basin.

### Material and methods

Morphological characters were obtained from all specimens of the type series, which were fixed in formalin one day after collection, for a period of 10 days, and then transferred to 70 % ethanol; they are deposited in the ichthyological collection of the Instituto de Biologia, Universidade Federal do Rio de Janeiro, Rio de Janeiro (UFRJ). Descriptions of color patterns were based both on direct examination of live specimens in aquaria just after collection, and photographs of both sides of live individuals (two males and two females) taken in aquaria one day after collection, just before fixation in formalin. Measurements and counts follow Costa (1995); 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), but cartilage was not stained to avoid ossification damage produced by the acetic acid present in the Alcian Blue solution. Terminology for bones follows Costa (2006), for frontal squamation Hoedeman (1958) and for cephalic neuromast series Costa (2001). Delimitation of species follows the Population Aggregation Analysis (Davis & Nixon, 1992), in which species are delimited by a unique combination of stable morphological character states occurring in one or more populations.

### *Hypsolebias nudiorbitatus*, new species (Figs. 1–2)

**Holotype.** UFRJ 6837, male, 41.8 mm SL; Brazil: Estado da Bahia: Município de Filadélfia: seasonal swamp adjacent to the das Jacas Creek, upper Itapicuru River basin, near road BA-381, about 2.5 km from Filadélfia village, 11°22'51"S 40°00'51"W, altitude 415 m; W. J. E. M. Costa et al., 10 May 2010.

**Paratypes.** UFRJ 6838, 1 male, 39.7 mm SL, 2 females, 33.5–34.8 mm SL (c&s); UFRJ 6839, 1 female, 36.6 mm SL; collected with holotype.

**Diagnosis.** *Hypsolebias nudiorbitatus* is distinguished from all other species of the *H. antenori* group in having a single, small scale on the posterior part of the supra-orbital region, sometimes absent (vs. usually two scales, sometimes one or three scales, occupying the whole supra-orbital region) (Fig. 3); caudal fin in males with white dots arranged in transverse rows (vs. irregularly arranged); 14 scale rows around caudal peduncle (vs. 16); dorsal fin placed slightly more posteriorly in males (predorsal length 50.9–53.0 % SL and dorsal-fin origin at vertical between base of fourth and fifth anal-fin rays in *H. nudiorbitatus*, vs. 41.8–50.6 % SL and vertical between base of first and fourth anal-fin rays, respectively, in the remaining species of the *H. antenori* group); and basihyal narrow, its width about 40 % of length (vs. about 65–90 %) (Fig. 4).

**Description.** Morphometric data appear in Table 1. Largest male examined 41.3 mm SL; largest female examined 36.6 mm SL. Dorsal profile approximately straight on head, with slight concavity at vertical through posterior orbital margin, convex from nape to end of dorsal-fin base, nearly straight on caudal peduncle. Ventral profile convex from lower jaw to end of anal-fin base, approximately straight on caudal peduncle. Body moderately deep, compressed, greatest body depth at level of pelvic-fin base. Eye positioned on dorsal portion of head side. Snout short, subtriangular in lateral view. Urogenital papilla cylindrical in males, short, slightly longer than wide; urogenital opening of females placed in pocket-like structure, slightly overlapping anal-fin origin.

Dorsal fin subtriangular in males, posterior extremity sharply pointed, with two short fila-



Fig. 1. *Hypsolebias nudiorbitatus*, UFRJ 6837, holotype, male, 41.8 mm SL; Brazil: Bahia: Filadélfia.

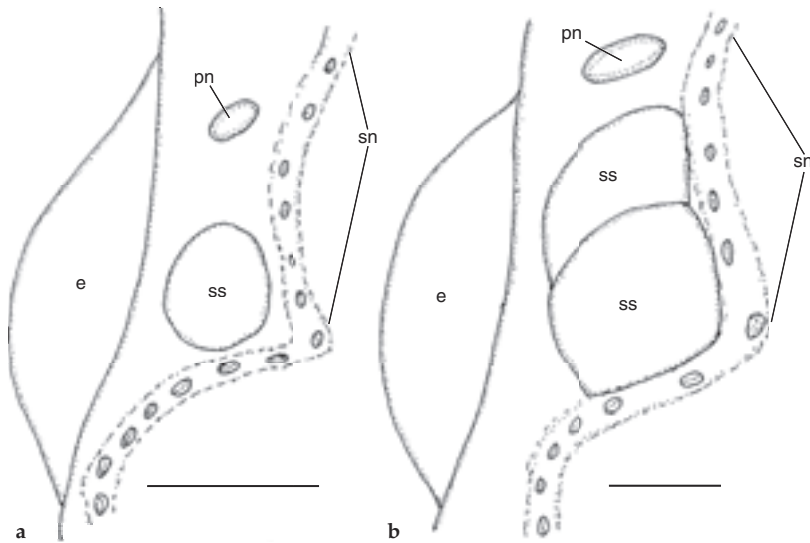


Fig. 2. *Hypsolebias nudiorbitatus*, UFRJ 6838, paratype, female, 33.5 mm SL; Brazil: Bahia: Filadélfia.

mentous rays on tip reaching vertical through middle of caudal-fin base; dorsal fin subtriangular to semi-circular in females, posterior extremity rounded to slightly pointed. Anal fin subtriangular in males, posterior extremity sharply pointed, with four short filamentous rays reaching vertical through middle of caudal-fin base; anal fin sub-trapezoidal in females, extremities rounded; distal portion of anterior rays strongly thickened. Caudal fin round. Pectoral fin long, elliptical to slightly pointed, tip reaching vertical of base of 6th anal-fin ray in males, reaching urogenital papilla in females. Tip of pelvic fin reaching base of 3rd anal-fin ray in males and reaching between urogenital papilla and base of

2nd anal-fin ray in females. Pelvic-fin bases medially fused. Dorsal-fin origin in vertical through base of 5th anal-fin ray in males, through base of 4th anal-fin ray in females. Second proximal radial of dorsal fin between neural spines of vertebrae 9 and 10 in males, and neural spines of vertebrae 11 and 13 in females. First proximal radial of anal fin between pleural ribs of vertebrae 7 and 8 in males, and pleural ribs of vertebrae 10 and 11 in females. Dorsal-fin rays 21–22 in males, 17–18 in females; anal-fin rays 22 in males, 20–21 in females; caudal-fin rays 23–25; pectoral-fin rays 11–12; pelvic-fin rays 6.

Frontal squamation E-patterned; E-scales overlapping medially; no row of scales anterior



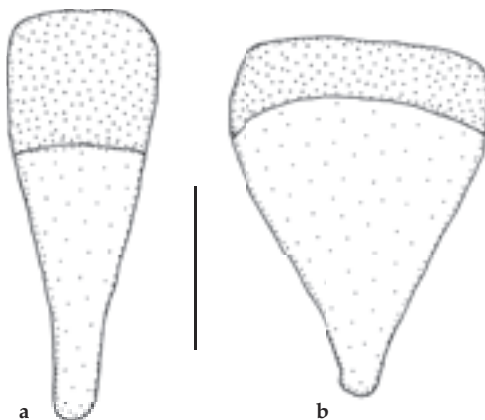
**Fig. 3.** Left supraorbital region, dorsal view, of: **a**, *Hypsolebias nudiorbitatus*, UFRJ 6838, male; **b**, *H. ghisolfii*, UFRJ 6066, male. Abbreviations: **e**, eye; **pn**, posterior nostril; **sn**, supraorbital series of neuromasts; **ss**, supraorbital scale. Scale bars 1 mm.

to H-scale; one small scale on posterior part of supra-orbital region (Fig. 3a), sometimes absent. Longitudinal series of scales 27–28; transverse series of scales 12; scale rows around caudal peduncle 14. One to four contact organs on each scale of anteroventral portion of flank in males. Minute contact organs on three dorsal-most rays of pectoral fin in males.

Cephalic neuromasts: supraorbital 16–17, parietal 2, anterior rostral 1, posterior rostral 1, infraorbital 2+23–26, preorbital 3, otic 3, post-otic 2–3, supratemporal 1, median opercular 1, ventral opercular 2, preopercular 18, mandibular 13, lateral mandibular 6–7, paramandibular 1. One neuromast on center of each scale of lateral line. Two neuromasts on caudal-fin base.

Basihyal subtriangular, width about 40 % of length; basihyal cartilage about 35 % of total length of basihyal. Six branchiostegal rays. Second pharyngobranchial teeth 7–8. Gill-rakers on first branchial arch 4+12. Vomerine teeth absent. Dermosphenotic absent. Ventral process of post-temporal long. Total vertebrae 28–29.

**Coloration.** Males. Side of body light gray, with 13 approximately straight gray bars, darker on caudal peduncle; vertical rows of white dots between bars. Venter pinkish white. Posterolateral portion of head and anterodorsal portion of trunk pale purple, with white spots. Opercular region pale golden, infraorbital region pale metallic blue. Iris light yellow, with dark purplish brown bar. Dorsal fin dark greenish gray with white dots, distal marginal region gray. Anal fin dark greenish gray with white dots on basal and posterior portions, with subdistal yellow zone and broad black distal margin. Caudal fin dark



**Fig. 4.** Basihyal bone, dorsal view, of: **a**, *Hypsolebias nudiorbitatus*, UFRJ 6838, male; **b**, *H. ghisolfii*, UFRJ 3808, male. Dense stippling indicates cartilage. Scale bar 1 mm.





greenish gray with transverse rows of white dots; distal margin bluish gray. Pectoral fin hyaline. Pelvic fin black with yellow base.

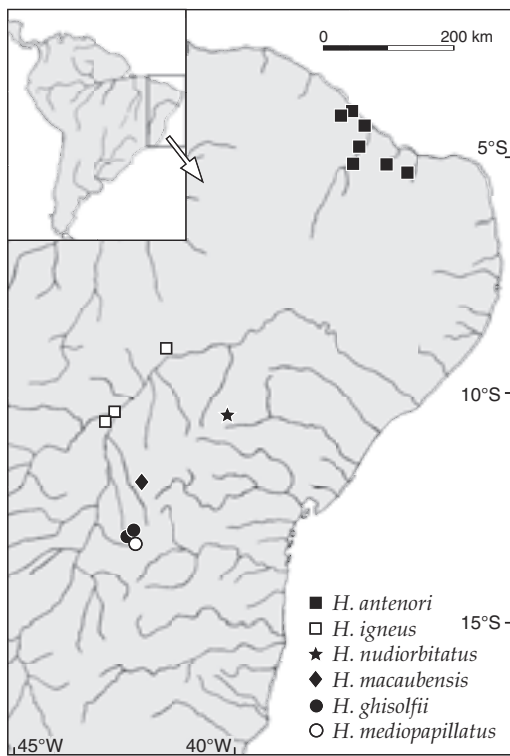
Females. Side of body pale brownish gray, sometimes with 13–15 faint gray bars; 2–4 black spots on anterocentral portion of flank, in vertical between pelvic-fin base and anterior portion of anal-fin base. Venter yellowish white. Opercular region pale golden, infraorbital region pale blue. Iris light yellow, with gray bar. Fins hyaline.

**Distribution and ecological notes.** *Hypsolebias nudiorbitatus* is known only from the type locality, a wide seasonal swamp adjacent to the das Jacas Creek, which is a small, seasonal stream of the upper Itapicuru River basin. The type locality is located in the semi-arid Caatinga region of northeastern Brazil, where both swamps and streams are dry between June and November. At the time of sampling, the swamp was shallow, about 0.4–0.8 m deep, the water was clear, and dense aquatic vegetation was present. All the individuals of the new species were found in the shade of bushes.

**Etymology.** From the Latin *nudiorbitatus* (with naked orbit), referring to the rudimentary or absent squamation on the supraorbital region. An adjective.

**Table 1.** Morphometric data of *Hypsolebias nudiorbitatus*. H, holotype.

|                                   | H     | paratypes |       |       |       |
|-----------------------------------|-------|-----------|-------|-------|-------|
|                                   | ♂     | ♂         | ♂     | ♀     | ♀     |
| Standard length (mm)              | 41.8  | 39.7      | 33.5  | 34.8  | 36.6  |
| <b>Percent of standard length</b> |       |           |       |       |       |
| Body depth                        | 39.3  | 36.6      | 36.5  | 39.8  | 38.6  |
| Caudal peduncle depth             | 15.4  | 13.9      | 13.5  | 14.8  | 14.3  |
| Predorsal length                  | 53.0  | 50.9      | 62.1  | 63.5  | 61.6  |
| Prepelvic length                  | 46.9  | 44.9      | 53.2  | 54.1  | 52.0  |
| Length of dorsal-fin base         | 39.4  | 39.0      | 26.1  | 28.3  | 27.5  |
| Length of anal-fin base           | 41.9  | 41.0      | 25.8  | 27.5  | 27.5  |
| Caudal-fin length                 | 33.9  | 34.9      | 33.6  | 32.8  | 34.3  |
| Pectoral-fin length               | 27.9  | 29.9      | 27.8  | 26.1  | 26.8  |
| Pelvic-fin length                 | 11.1  | 10.8      | 12.1  | 11.1  | 10.9  |
| Head length                       | 28.5  | 27.9      | 29.3  | 30.4  | 30.5  |
| <b>Percent of head length</b>     |       |           |       |       |       |
| Head depth                        | 115.2 | 108.3     | 102.3 | 103.4 | 103.3 |
| Head width                        | 71.8  | 69.0      | 73.4  | 69.0  | 73.6  |
| Snout length                      | 13.1  | 15.5      | 12.8  | 12.0  | 15.0  |
| Lower jaw length                  | 19.0  | 18.6      | 14.8  | 16.9  | 16.7  |
| Eye diameter                      | 25.3  | 27.3      | 28.4  | 27.2  | 26.9  |



**Fig. 5.** Geographic distribution of the members of the *Hypsolebias antenori* species group.

## Discussion

*Hypsolebias nudiorbitatus* is a typical member of the *H. antenori* species group, possessing all diagnostic features of that clade (see Introduction above). Among species of the *H. antenori* group, two sister clades have been proposed in phylogenetic studies (Costa, 2010a), the first one comprising three species endemic to the São Francisco River basin, *H. flagellatus*, *H. flavicaudatus* and *H. janaubensis*, and the second containing five species more geographically widespread in northeastern Brazil: *H. antenori*, from the area between the coastal plains near the city of Fortaleza and the Piranhas River basin; *H. ghisolfii*, *H. macaubensis* and *H. mediopapillatus*, from the upper sections of eastern drainages of the middle section of the São Francisco River basin; and, *H. igneus*, from the left floodplains of the middle portion of the main São Francisco River channel (Fig. 5). The first clade is diagnosed by the absence of brilliant dots on the flank in males, or rarely when dots are present, they are just restricted to the dorsal



portion of the flank (vs. always present, scattered over whole flank) and anal fin with a unique color pattern consisting of anterior portion pink and posterior portion light yellow (Costa, 2003, 2010a), which are apomorphic conditions not present in *H. nudiorbitatus*. In contrast, *H. nudiorbitatus* has all the diagnostic features of the second clade, comprising two apomorphic color pattern elements in males: a broad, black distal stripe on the anal fin and a broad bluish gray to light blue distal bar on the caudal fin (Costa, 2010a).

Presently, it is not clear to which species of the second clade *H. nudiorbitatus* is more closely related. The color pattern of the distal portion of the anal fin in males of *H. nudiorbitatus* is similar to that shared by *H. ghisolfii* and *H. mediopapillatus*, in which there is a subdistal yellow zone on the anal fin in males (Fig. 1). However, according to the most recent phylogenetic study among species of *Hypsolebias*, this color pattern is plesiomorphic for the second clade of the *H. antenori* species group (Costa, 2010a). In addition to those unique morphological character states described above for *H. nudiorbitatus*, it also differs from *H. ghisolfii* and *H. mediopapillatus* by having well developed contact organs on the anteroventral portion of the flank in males (vs. rudimentary or absent), a short urogenital papilla in males, slightly longer than wide (vs. long, twice or more longer than wide), and by possessing straight bars on the caudal peduncle in males (vs. zigzag shaped).

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### Cover Photograph

*Sundadanio axelrodi* (photograph by Koji Yamazaki)

Kevin W. Conway, Maurice Kottelat and Tan Heok Hui  
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