

Hypsolebias trifasciatus, a new species of annual fish (Cyprinodontiformes: Rivulidae) from the rio Preto, rio São Francisco basin, northeastern Brazil

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Abstract

Hypsolebias trifasciatus n. sp. is described from a temporary pool located on the left bank of the rio Preto, a tributary of the rio São Francisco. It is the first species of the *H. adornatus* complex recorded in a tributary rather than the rio São Francisco main channel. This species is distinguished from the remaining *Hypsolebias* species, with the exception of those belonging to the *H. adornatus* complex, by the high number of dorsal fin rays (27-28), and consequently a large dorsal fin base length, beginning considerably anteriorly to the middle of the body, before the vertical line through the pelvic fin. The new species differs from the remaining species of the *H. adornatus* complex by the color pattern of the anal fin, which consists in longitudinal, alternating three yellow and three black stripes (vs. stripes absent in the remaining *Hypsolebias* of the *H. adornatus* complex, or relatively inconspicuous 2 yellow stripes and 2-3 gray stripes in *H. lopesi*), and a unique pattern of the dorsal-fin color in males, with the presence of two groups of 3-4 irregularly-shaped, large yellow spots (vs. absence of a such pattern in the remaining *Hypsolebias* of the *H. adornatus*-group).

Zusammenfassung

Hypsolebias trifasciatus n. sp. wird von einem zeitbegrenzten Tümpel am linken Ufer des Rio Preto beschrieben, der als Nebenfluss zum Einzugsgebiet des Rio São Francisco gehört. Es handelt sich um die erste Art des *H.-adornatus*-Komplexes, die in einem Nebenfluss nachgewiesen wurde, und nicht im Hauptstrom des Rio São Francisco. Diese neue Art unterscheidet sich von den übrigen *Hypsolebias*-Arten – mit

Ausnahme derjenigen, die zum *H.-adornatus*-Komplex gehören – durch eine hohe Zahl von Rückenflossenstrahlen (27-28) und folglich eine große Länge der Rückenflossenbasis, die deutlich vor der Körpermitte beginnt, noch vor einer Senkrechten über der Bauchflosse. Von den anderen Arten des *H.-adornatus*-Komplexes unterscheidet sich die neue Art durch das Färbemuster der Afterflosse, auf der sich in Längsrichtung drei gelbe und drei schwarze Streifen abwechseln (im Vergleich dazu gibt es bei *H. lopesi* 2 unauffällige gelbe Streifen und 2-3 graue Streifen, während bei den anderen Arten des *H.-adornatus*-Komplexes Streifen sogar ganz fehlen). Weiterhin zeigen die Männchen der neuen Art ein unverkennbares Muster auf der Rückenflosse: zwei Gruppen mit 3-4 unregelmäßig geformten großen gelben Flecken (bei den übrigen *Hypsolebias*-Arten der *H.-adornatus*-Gruppe fehlt ein solches Muster ganz).

Resumo

Hypsolebias trifasciatus n. sp. é descrita de uma poça temporária localizada na margem esquerda do rio Preto, afluente do Rio São Francisco. É a primeira espécie do complexo *H. adornatus* encontrada em um tributário, fora do canal principal do rio São Francisco. Esta espécie se distingue das demais espécies de *Hypsolebias*, exceto aquelas do complexo *H. adornatus*, pelo grande número de raios da nadadeira dorsal (27-28), que se inicia anterior ao meio do corpo, antes da linha vertical que passa pela nadadeira pélvica. Esta espécie difere das demais do complexo *H. adornatus* pelo padrão de colorido da nadadeira anal, composto por três listras amarelas e três listras pretas longitudinais e alternadas, bem definidas (vs. ausentes em outras

Hypsolebias do grupo *H. adornatus*, ou 2 barras amarelas e 2-3 barras cinza pouco definidas em *H. lopesi*) e um padrão único da cor da nadadeira dorsal em machos, com a presença de dois grupos de 3-4 manchas amarelas relativamente grandes e irregulares (vs. ausência deste padrão de colorido na nadadeira dorsal nas demais espécies do grupo *H. adornatus*).

Résumé

Hypsolebias trifasciatus n. sp. est décrit provenant d'une mare temporaire, située sur la rive gauche du rio Preto, un tributaire du rio São Francisco. C'est la première espèce du complexe *H. adornatus* collecté dans un tributaire plutôt que dans le cours principal du rio São Francisco. Cette espèce se distingue des autres espèces d'*Hypsolebias*, à l'exception de celles appartenant au complexe *H. adornatus*, par le nombre élevé de rayons à la dorsale (27 - 28) et, par conséquent, par une grande longueur de base de la dorsale, commençant antérieurement au milieu du corps, avant la ligne verticale traversant la pelvienne. La nouvelle espèce diffère des autres espèces du complexe *H. adornatus* par le patron de coloration de l'anale, qui consiste en trois lignes longitudinales jaunes et noires qui alternent (vs. des lignes absentes pour les autres *Hypsolebias* du complexe *H. adornatus* ou, plutôt vagues, 2 lignes jaunes et 2 - 3 grises chez *H. lopesi*) et un patron de coloration de la dorsale pour les mâles, avec deux groupes de grandes taches jaunes de forme irrégulière (vs. absence d'un tel patron pour le reste des *Hypsolebias* du groupe *H. adornatus*).

Sommario

Hypsolebias trifasciatus n. sp. è descritta da una pozza temporanea localizzata sulla riva sinistra del Rio Preto, un affluente del Rio São Francisco. È la prima specie del complesso *H. adornatus* registrato in un affluente piuttosto che nel corso principale del Rio São Francisco. Questa specie si distingue dalle restanti specie di *Hypsolebias*, ad eccezione di quelle appartenenti al complesso *H. adornatus*, per l'elevato numero di raggi dorsali (27-28), e di conseguenza per una lunga base della pinna dorsale, la quale inizia molto anteriormente rispetto al centro del corpo, prima della linea verticale che passa per la pinna pelvica. La nuova specie differisce dalle altre specie del complesso *H. adornatus* per la colorazione della pinna anale, che consiste in tre strie longitudinali gialle alternate a tre strie nere (assenti nelle restanti specie di *Hypsolebias* del complesso *adornatus*, o relativamente poco evidenti 2 strie gialle e 2-3 strie grigie in *H. lopesi*), e per la presenza di due gruppi di 3-4 grandi macchie gialle di forma irregolare sulla pinna dorsale dei maschi (vs. mancanza di tale motivo nelle altre specie del gruppo *H. adornatus*).

INTRODUCTION

The genus *Hypsolebias* is one of the most speciose of annual fish genera in South America, with 45 species recognized so far (Eschmeyer 2014). Most species of the genus occur at the rio São Francisco

basin, but some are found in the rio Tocantins basin in Central Brazil, the rio Jaguaribe, the rio Parnaíba and some small coastal basins in northeastern Brazil (Costa 2007). The genus is divided into 4 groups (Costa 2006): the *Hypsolebias flammeus* group, the *Hypsolebias notatus* group, the *Hypsolebias antenori* group, and the *Hypsolebias magnificus* group. The new species described herein belongs to the *Hypsolebias magnificus* group, which is contained within the *Hypsolebias adornatus* complex (Costa 2013). This group is easily identifiable due to the long dorsal fin, which begins before the pelvic fin in males and the presence of two small black spots in the caudal peduncle of females.

The following species belong to the *H. adornatus* complex: *H. adornatus* (Costa 2000), *H. lopesi* (Nielsen et al. 2010), and *H. caeruleus* Costa, 2013. The remaining species belonging to the *Hypsolebias magnificus* group are: *H. magnificus* (Costa & Brasil 1991), *H. carlettoi* (Costa & Nielsen 2004), *H. fulminantis* (Costa & Brasil 1993), *H. hellneri* (Berkenkamp 1993), *H. picturatus* (Costa, 2000), *H. hamonicus* (Costa 2010), and *H. shibat-tai* Nielsen, Martins, Araújo & Suzart 2014.

All species of the *H. adornatus* complex currently known have their distribution just a few kilometers from the shores of the rio São Francisco: 1.5 km (*H. adornatus*), 26 km (*H. lopesi*), and 35 km (*H. caeruleus*). The new species is found in a left bank tributary of the rio São Francisco, the rio Preto, about 140 km in a straight line from the rio São Francisco or about 170 km as measured along the course of the rio Preto, the furthest ever known for a species of the *H. adornatus* complex group from the rio São Francisco, and also the first ever found at the western portion of that basin.

MATERIAL AND METHODS

Measurements were taken point-to-point under a stereomicroscope with a digital caliper to the nearest 0.1 mm on the left side of the specimen following Costa (1995; 2007). Measurements are expressed as percents of standard length (SL), except subunits of the head, which are recorded as percents of head length (HL).

In the description, counts of vertebrae and pleural ribs were taken from cleared and stained (c&s) of one male and one female paratypes, prepared according to Taylor & Van Dyke (1985). Fertilization followed Hoedeman (1958) and Costa (2006). For vertebral counts the caudal unpigmented centrum was counted as a single element.

Osteological features included in the description are those considered phylogenetically informative in recent studies of the species formerly assigned to the genus *Simpsonichthys* (Costa 2003; 2007).

Institutional abbreviations are UNITAU (University of Taubaté, Taubaté, Brazil) and ZUEC (Museu de Zoologia da Universidade Estadual de Campinas, Campinas, Brazil). Comparisons with

congeners were based primarily on the literature (Costa 2007; 2013, Nielsen et al. 2010).

Hypsolebias trifasciatus, n. sp.
(Figs 1-2; Table 1)

Holotype: ZUEC 8302, 1 male, 30.7 mm SL:



Fig. 1. *Hypsolebias trifasciatus*, ZUEC 8302, male, holotype, 30.7 mm SL: Brazil, Bahia, Santa Rita de Cássia. Photo by D. Nielsen.

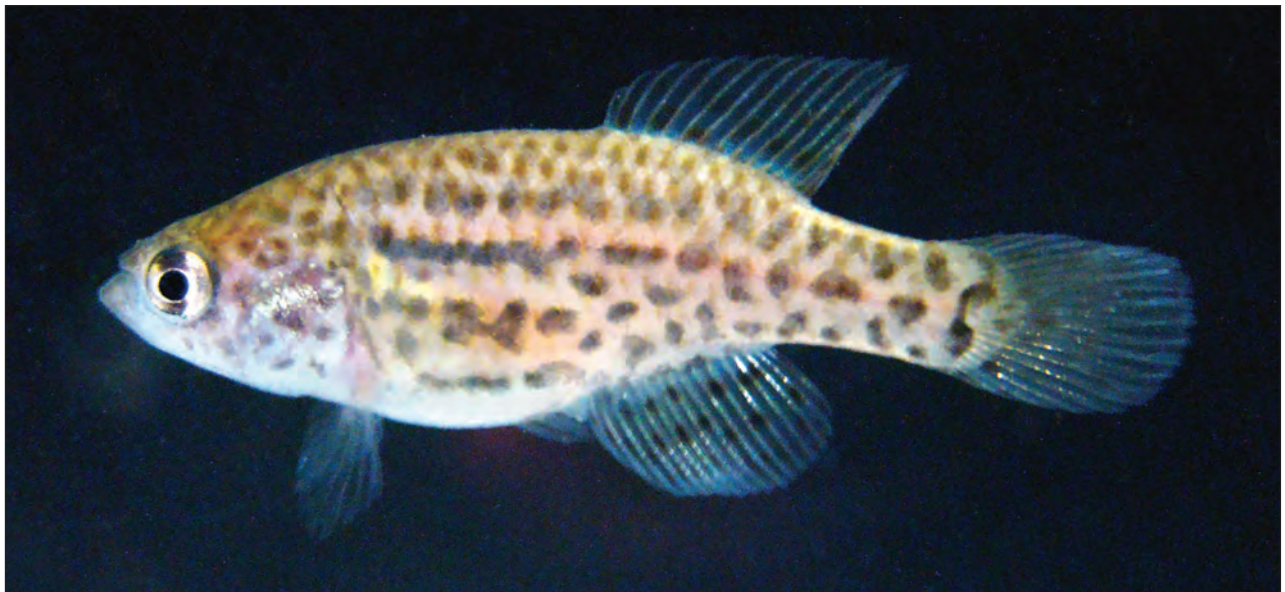


Fig. 2. *Hypsolebias trifasciatus*, ZUEC 8303, female, paratype, 24.0mm SL: Brazil, Bahia, Santa Rita de Cássia. Photo by D. Nielsen.

Brazil, Bahia, Santa Rita de Cássia, rio Preto, rio São Francisco basin, temporary pool at road BA-225, 11°02'33.1"S, 44°18'25.4"W, altitude 450 m; Dalton Tavares Bressane Nielsen & Amer Four, 25 January 2014.

Paratypes: ZUEC 8303, 5 males 30.1-33.0 mm SL, 5 females 21.2-24.0 mm SL; 2 c&s, one male 33.0 mm and one female 21.8 mm, all collected with holotype.

Diagnosis: *Hypsolebias trifasciatus* differs from the remaining species of *Hypsolebias* by its unique color

of the dorsal-fin in males, with the presence of two groups of 3-4 yellow, irregularly-shaped, large spots (vs. absence of a such pattern in the remaining *Hypsolebias*), and the presence of longitudinal, alternating three yellow and three black stripes (vs. stripes absent in the remaining *Hypsolebias* of the *H. adornatus* complex, or relatively inconspicuous 2 yellow stripes and 2-3 gray stripes in *H. lopesi*). Additionally, *Hypsolebias trifasciatus* can be distinguished from all other species of *Hypsolebias*, except *H. adornatus*, *H. lopesi*, and *H. caeruleus* by



Fig. 3. *Hypsolebias adornatus*, male. Brazil, Bahia, Sítio do Mato (not preserved). Photo by M. Chauche.



Fig. 4. *Hypsolebias lopesi*, male. Brazil, Bahia, Javi. Photo by R. Suzart.

Table I. Morphometric and meristic data for the holotype (H) and paratypes of *Hypsolebias trifasciatus*.

	H	Paratypes	
	Male	Male n=5	Females n=5
Standard length (mm)	30.7	30.1-33.0	21.2-24.0
Percents of standard length			
Body depth	33.8	32.5-35.5	33.0-35.3
Caudal peduncle depth	15.3	13.6-14.8	14.6-15.6
Pre-dorsal length	36.5	36.9-42.2	59.9-64.1
Pre-pelvic length	41.7	41.8-42.7	47.3-50.4
Length of dorsal-fin base	47.9	45.5-50.4	22.6-25.0
Length of anal-fin base	36.8	36.5-39.6	22.0-25.0
Caudal-fin length	23.7	21.9-25.9	25.6-26.4
Pectoral-fin length	20.9	20.2-22.4	16.6-21.7
Pelvic-fin length	9.1	7.1-9.9	8.4-12.0
Head length	29.9	29.6-31.0	30.6-31.2
Percents of head length			
Head depth	86.9	83.7-88.9	76.4-81.3
Head width	44.5	42.5-49.3	41.6-45.3
Lower jaw length	24.5	22.8-26.5	21.8-25.6
Eye diameter	27.1	26.5-30.8	29.3-33.3
Meristics			
Dorsal fin	28	27-28	16
Caudal fin	25	24-25	24
Anal fin	21	20-21	16-18
Pelvic fin	5	5	5
Pectoral fin	12	11-12	11
Scales in longitudinal series	25	25-26	26
Scales in transversal series	09	9-10	9
Horizontal scales around Caudal peduncle	12	12	10

having dorsal-fin origin in front of pelvic-fin base in males (vs. posterior to that point), sides of body blue in males (vs. never blue), and two black spots, vertically aligned, immediately anterior to the caudal-fin base in females (vs. spots, when present, not aligned).

Females have dorsal fins slightly pointed (vs. rounded), unpaired fins with black spots (vs. spots absent in *H. adornatus*, gray spots in *H. caeruleus* and *H. lopesi*), black spots immediately anterior to caudal-fin base, when present, small and irregularly shaped (vs. presence of two black blotches in the other species of the *H. adornatus* complex). Additional characters diagnosing the new species from congeners are presented in the Discussion.

Description: Morphometric data is presented in

Table I. Largest specimen examined 33.0 mm SL. Dorsal profile convex from snout to end of dorsal-fin base, approximately straight along caudal peduncle. Ventral profile convex from lower jaw to end of anal fin base, nearly straight along caudal peduncle. Body deep, compressed, greatest body depth at level of pelvic fin base. Snout blunt. Urogenital papilla cylindrical and short in males, pocket-shaped in females.

Tip of dorsal fin pointed in males, slightly pointed in females; tip of anal fin rounded in both sexes. Tips of dorsal-fin rays 23-26 developed as short filaments in males, reaching vertically through the middle of the caudal fin; filaments absent in anal fin. Dorsal-fin rays unbranched. Caudal-fin rounded. Pectoral-fins elliptical. Posterior margin of pectoral fin reaching vertical through base of 3rd anal-fin ray in males, and between pelvic-fin base and urogenital papilla in females. Tip of each pelvic fin reaching base of 4th anal fin ray in males and base of 1st anal-fin ray in females. Pelvic fin bases in close proximity. Dorsal fin origin anterior to anal fin origin in males, anal fin origin on vertical through base of 8th dorsal-fin ray; dorsal fin origin and anal fin origin at the same level in females. Dorsal fin origin between the neural spines of the 4th and 5th vertebrae in males, and the neural spines of the 11th and 12th vertebrae in females. Anal fin origin between the pleural ribs of vertebrae 8 in males, and the pleural ribs of vertebrae 10 and 11 in females. Dorsal-fin rays 27-28 in males, 16 in females; anal-fin rays 20-21 in males, 16-18 in females; caudal-fin rays 24-25; pectoral-fin rays 11-12; pelvic-fin rays 5.

Frontal squamation E-patterned; E-scales overlapping medially; no row of scales anterior to G-scale; supraorbital scales 2. Longitudinal series of scales 25-26; transverse series of scales 9-10; scale rows around caudal peduncle 10-12. Contact organs absent.

Cephalic neuromasts: supraorbital 12-14, parietal 2, anterior rostral 1, posterior rostral 1, infraorbital 4+20-21, preorbital 3, otic 1, post-otic 2, supratemporal 1, median opercular 1, ventral opercular 1, preopercular 12-14, mandibular 9-11, lateral mandibular 5, paramandibular 1. Two neuromasts on caudal-fin base. Total vertebrae 25.

Coloration in life (Figs 1-2): Males: Sides of body light blue to purplish blue, with 6-7 metallic blue spot rows horizontally. Parallel spots larger anteriorly, decreasing in size towards caudal-fin base. Head with dorsal and pre-dorsal areas red-

dish-yellow. Opercular area light yellow with an iridescent blue hue. Iris pale yellow, black vertical stripe across eyes. Dorsum gray, ventral area whitish. Sides of head light blue, opercular region bright blue, poster-dorsal scales with red margin in the head. Dorsal fin with two different patterns: anterior portion with bright blue lines, followed by yellow blotches; posterior area of dorsal fin with 3-4 small aligned bright blue spots followed by large yellow blotches, followed by 2-3 rows of bright blue spots. Anal fin with 7 longitudinal stripes, stripe at fin base white, followed by six alternating yellow/black stripes.

Caudal fin basis and medial portion golden yellow, distal portion hyaline, with rows of small blue spots. Pelvic fin light yellow. Pectoral fin hyaline.

Females: Body sides light purplish gray, golden hue on abdominal area, with horizontal rows of small dark brownish gray spots, sometimes coalesced forming horizontal stripes; spots on anterior and central portions of flanks black. Head with dorsal and pre-dorsal areas grayish-yellow. Opercu-

lar area light yellow, with an iridescent green hue and small gray blotches. Pair of black spots at caudal peduncle absent or when present, irregularly-shaped and small. Iris light yellow, with dark gray vertical stripe through center of eye. Unpaired fins hyaline, with longitudinal rows of small black spots on interradial membranes. Pectoral and pelvic fins hyaline.

Distribution (Fig. 5): Known only from the type locality, a temporary pool beside the highway BA-225, at Santa Rita de Cássia, rio Preto, rio São Francisco basin, Bahia state, Brazil.

Habitat (Fig. 6): The new species was found 3.8 km from the left bank of the rio Preto, in a region of dense Caatinga/Cerrado ecotone. The type locality is a typical annual pool with many aquatic plants of the genera *Echinodorus*, *Utricularia*, and *Nymphaea*. The pool measured about 800 m in length and 300 meters of width, with 1.60 m of maximum depth. The substrate was composed of clay. The water was transparent and slightly dark in color. The new species was the only fish species

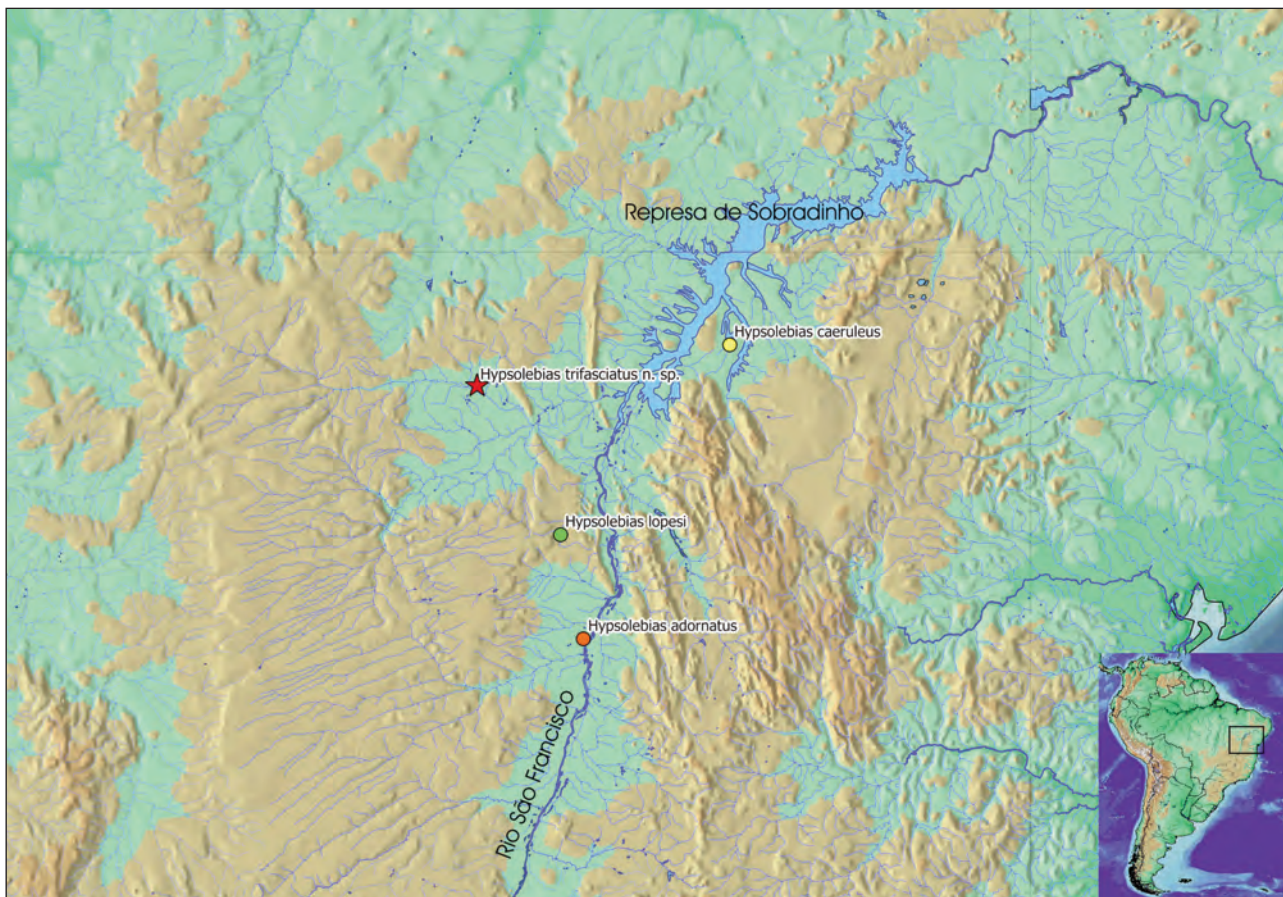


Fig. 5. Map from northeastern Brazil (inset) showing known localities for species of the *H. adornedatus* complex.

found at the pool, which was shared with many aquatic insect larvae and several tadpole species.

Behavior in captivity: In the aquarium males showed a very aggressive territorial behavior towards other males and were also aggressive with the females during the reproductive behavior. There was intense fighting between males, which often resulted in death of the weaker individuals. Females had their fins damaged. However, at the pool, no fish with signs of damage due to aggression were found. Probably in the pool males do not aggressively conflict to defend their territory, just expelling the intruders with their displays (Nielsen 2008). In other annual rivulid fishes, males are less aggressive and typically does not kill its potential males competitors.

Etymology: The epithet “*trifasciatus*” refers to the color pattern of the anal fin of males.

DISCUSSION

Hypsolebias trifasciatus is easily distinguishable from its congeners by unique dorsal-fin color pat-

tern in males, and the unique color pattern of the anal fin with alternating three black and three yellow bands, absent in the remaining species of *Hypsolebias adornatus* complex.

In addition to the characters referred in the Diagnosis, males of *Hypsolebias trifasciatus* can be distinguished from *H. adornatus* by having a higher predorsal length (36.9-42.2% SL vs. 28.3-34.4% SL), higher prepelvic length (41.8-42.7% SL vs. 39.2-40.8% SL), lower dorsal-fin base length (45.5-50.4% SL vs. 54.0-60.3% SL), lower anal-fin base length (36.5-39.6% SL vs. 43.4-48.2% SL), lower caudal-fin length (21.9-25.9% SL vs. 29.3-32.5% SL), larger head length (29.6-31.0% SL vs. 24.4-27.2% SL), lower head depth (83.7-88.9% HL vs. 106.8-113.8% HL), lower head width (59.3-64.2% HL vs. 67.2-75.9% HL), fewer number of scales in longitudinal series (25-26 vs. 27-29), and absence of contact organs (vs. small papillate contact organs on inner portion of three dorsalmost pectoral-fin rays).

Females of *Hypsolebias trifasciatus* can be distin-



Fig. 6. Type locality of *Hypsolebias trifasciatus*, Brazil, Bahia, Santa Rita de Cássia. Photo by D. Nielsen.

guished from *H. adornatus* by having a lower caudal-fin length (25.6-26.4% SL vs. 29.6-30.2% SL), higher head length (30.6-31.2% SL vs. 26.7-27.4% SL), lower head depth (76.4-81.3% HL vs. 98.3-108.9% HL), lower head width (41.6-45.3% HL vs. 73.7-78.2% HL), tip of dorsal-fin slight pointed (vs. rounded), and sides of body with larger gray spots (vs. small black rows).

Males of *Hypsolebias trifasciatus* can be additionally distinguished from *H. lopesi* by the absence of red scales (vs. presence of dorsal scales light red pigmentation at their edge, from snout to base of caudal fin), dorsal-fin pointed (vs. rounded), higher head length (29.6-31.0% SL vs. 24.7-27.3% SL), lower snout length (12.9-14.5% HL vs. 19.2-27.0% HL), and absence of papillate contact organs (vs. small papillate contact organs on the inner surface of the three dorsalmost pectoral-fin rays).

Females of *Hypsolebias trifasciatus* can be distinguished from *H. lopesi* by having a higher body depth (33.0-35.3% SL vs. 22.1-32.7% SL), higher caudal peduncle depth (14.6-15.6% SL vs. 11.2-14.3% SL), larger head length (30.6-31.2% SL vs. 25.1-30.0% SL), and shorter snout length (11.5-12.8% HL vs. 17.9-20.9% HL).

Males of *Hypsolebias trifasciatus* can be distinguished from *H. caeruleus* by having higher predorsal length (36.9-42.2% SL vs. 31.8-34.7% SL), lower prepelvic length (41.8-42.7% SL vs. 43.6-44.2% SL), lower length dorsal fin base (45.5-50.4% SL vs. 51.9-53.5% SL), lower anal-fin base length (36.5-39.6% SL vs. 40.0-41.3% SL), lower caudal fin length (21.9-25.9% SL vs. 33.2-35.5% SL), lower pectoral-fin length (20.2-22.4% SL vs. 25.2-26.5% SL), lower head depth (83.7-88.9% HL vs. 104.0-108.0% HL), lower eye diameter (26.5-30.8% HL vs. 33.0% HL), fewer number of dorsal fin rays (23-25 vs. 28-31), higher number of pelvic fin rays (6 vs. 5), fewer number of transverse series of scales (9-10 vs. 12), fewer number of scale rows around the caudal peduncle (11-12 vs. 14), and absence of contact organs (vs. minute contact organs on three dorsalmost pectoral-fin rays).

Females of *Hypsolebias trifasciatus* can be distinguished from *H. caeruleus* by having a higher caudal peduncle depth (14.6-15.6% SL vs. 12.8-13.7% SL), lower dorsal-fin base length (22.6-25.0% SL vs. 25.2-26.1% SL), lower pectoral-fin length (16.6-21.7% SL vs. 22.3-24.7% SL), longer head length (30.6-31.2% SL vs. 26.5-28.2% SL), lower head depth (76.4-81.3% HL vs. 89.0-102.0% HL), fewer number of dorsal fin rays (12-

13 vs. 17-18), fewer number of anal fin rays (15-18 vs. 19-20), higher number of caudal fin rays (24 vs. 23), higher number of pelvic fin rays (6 vs. 5), snout rounded, blunt (vs. pointed), and absence of small black spots on sides of body (vs. small black spots present on the anterior to middle portions of sides of body).

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