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Astyanax douradilho, a new characid fish from the rio Tramandaí system, southern Brazil (Characiformes: Characidae)

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Abstract

Astyanax douradilho, new species, is described from the rio Tramandaí system, coastal drainage of Rio Grande do Sul State, Brazil. The new species is distinguished from its congeners by possessing 37–39 perforated scales along the lateral line, 3–5 maxillary tricuspid teeth, 22–24 branched anal-fin rays, absence of a conspicuous dark stripe from humeral region to caudal peduncle, two vertically elongated humeral spots, head length (26.0–29.9% of standard length), upper jaw length (43.8–50.6% of head length), and snout length (23.0–28.6% of HL).

Key words: Neotropical fish, Atlantic Forest, Rio Grande do Sul, rio Maquiné, Lambari-escuro

Resumo

Astyanax douradilho, espécie nova, é descrita do sistema do rio Tramandaí, drenagem costeira do estado do Rio Grande do Sul, Brasil. A espécie nova distingui-se das suas congêneres pela presença de 37–39 escamas perfuradas na linha lateral, 3–5 dentes tricuspidados no maxilar, 22–24 raios ramificados na nadadeira anal, ausência de uma faixa escura entre a região umeral e o pedúnculo caudal, duas manchas umerais verticalmente alongadas, comprimento da cabeça (26,0–29,9% do comprimento padrão), comprimento do maxilar (43,8–50,6% do comprimento da cabeça) e comprimento do focinho (23,0–28,6% do CC).

Introduction

The genus *Astyanax* Baird & Girard is a speciose characid genus, comprising 140 valid species distributed from southern United States to central Argentina (Lima *et al*. 2003, Eschmeyer 2013). According to recent phylogenies *Astyanax* does not represent a monophyletic group (Mirande 2010; Javonillo *et al*. 2010; Oliveira *et al*. 2011), and so far it has been defined by a combination of characters proposed nearly a century ago by Eigenmann (1921, 1927): two rows of premaxillary teeth, five teeth in the inner premaxillary series, lateral line complete, adipose fin present, and caudal fin naked. Nevertheless, all these characters are also shared by other genera in the family Characidae.

The rio Tramandaí system is situated in the northeastern of Rio Grande do Sul State, and is divided into two subregions based on both geological origin and environmental characteristics: (1) the rios Maquiné and Três Forquilhas, located on the eastern coast of the steep edge of the Serra Geral, and (2) the lagoons sequentially interconnected situated on the Coastal Plain (Malabarba & Isaia 1992; Malabarba *et al*. 2013).

According to Lucena *et al*. (2013a,b), are recognized seventeen species of *Astyanax* from the rio Uruguay, laguna dos Patos, and rio Tramandaí drainages. During a revisionary study of the genus *Astyanax* from these basins, a new species was recognized from tributaries of the rio Maquiné, rio Tramandaí system, and it is herein described.

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Material and methods

Counts and measurements were taken as described by Fink & Weitzman (1974) and Bertaco & Lucena (2006). Counts of vertebrae, supraneurals, and procurrent caudal-fin ray counts were taken from cleared and stained (c&s) specimens prepared according to Taylor & Van Dyke (1985). Vertebral counts included the four vertebrae of the Weberian apparatus and the terminal centrum was counted as a single element. In the description an asterisk indicates counts of the holotype and the frequency of each count is provided in parentheses after the respective count. Sex of adult specimens was recognized by visual examination of their gonads, anal-fin profile and/or by the presence or absence of bony hooks in fin rays.

Measurements were taken point to point with a caliper on the left side of specimens whenever possible. Measurements are expressed as percentage of standard length (SL) except for subunits of the head which are recorded as percentage of head length (HL).

Specimens examined belong to Museu de Ciências Naturais, Fundação Zoobotânica do Rio Grande do Sul, Porto Alegre (MCN), Museu de Ciências e Tecnologia, Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre (MCP), and Departamento de Zoologia, Universidade Federal do Rio Grande do Sul, Porto Alegre (UFRGS). The comparative material is listed in Bertaco & Lucena (2006, 2010) and Lucena *et al*. (2013a,b).

Results

***Astyanax douradilho*, new species**
(Figs. 1–2, Table 1)

Holotype. MCN 19858, 1, 90.0 mm SL, Brazil, Rio Grande do Sul State, municipality of Maquiné, Barra do Ouro District, rio Maquiné basin, rio Tramadaí system, arroio Encantado, 29º36’28”S 50º12’15”W, 1 Nov 2013, V.A. Bertaco, M.A. Azevedo, C.L. Castilho & A.C. Vigo.

Paratypes. Brazil, Rio Grande do Sul State, municipality of Maquiné, Barra do Ouro District, rio Maquiné basin, rio Tramadaí system. MCN 19895, 10, 51.3-72.7 mm SL, UFRGS 18390, 7, 60.5-65.5 mm SL, rio do Ouro, 29º35’12”S 50º17’00”W, 16 Dec 2010, C. Vogel, G. Rosa & L. Artioli. MCN 19896, 6, 63.7-76.0 mm SL, rio do Ouro, 29º35’12”S 50º17’00”W, 11 Jan 2011, C. Vogel, R. Paesi & G. Rosa. MCP 25371, 2, 57.1–58.3 mm SL, arroio Encantado, 29º36’28”S 50º12’15”W, 1 Sep 1999, F.G. Becker, M. Vassiliou & G. Irgang. MCP 25479, 2, 68.6–72.0 mm SL, arroio Encantado, 29º36’28”S 50º12’15”W, 31 Aug 1999, F.G. Becker, M. Vassilou & T. Finkler. MCP 25692, 1, 73.9 mm SL, arroio Lageado (Cerrito), 29º34’16”S 50º16’51”W, 4 Sep 1999, F.G. Becker, G. Irgang & M. Vassiliou. MCP 25693, 2, 59.6–67.4 mm SL, arroio Forqueta, 29º32’42”S 50º14’21”W, 23 Feb 2000, F.G. Becker, F.S. Villela, M.F. Corrêa & C.S. Villela. MCP 25698, 3, 63.7–75.2 mm SL, arroio Forqueta, 29º32’42”S 50º14’21”W, 26 Feb 2000, F.G. Becker, F.S. Villela, M.F. Corrêa & C.S. Villela. MCP 25700, 12 (3 c&s), 46.0–70.5 mm SL, arroio Encantado, 29º36’28”S 50º12’15”W, 26 Feb 2000, F.G. Becker, F.S. Villela, M.F. Corrêa & C.S. Villela. MCP 25708, 2, 48.4–60.0 mm SL, arroio Encantado, 29º36’28”S 50º12’15”W, 22 Jan 2000, F.G. Becker, F.S. Villela, M.F. Corrêa & M.B. Fonseca.

Diagnosis. *Astyanax douradilho* differs from all congeners inhabiting the rio Uruguay basin, laguna dos Patos and rio Tramandaí systems by the presence of 3–5 maxillary tricuspid teeth, except from *A. henseli* Melo & Buckup, *A. laticeps* (Cope), and *A. paris* Azpelicueta, Almirón & Casciotta, and by the absence of a conspicuous dark stripe from humeral region to caudal peduncle. Additionally, it differs from *A. henseli* by the number of gill rakers on lower branch of first arch (11–12 *vs*. 15–19), from *A. laticeps* by the number and shape of humeral spots (two vertically elongate *vs*. one oval horizontally elongate), and from *A. paris* by the number of perforated scales along the lateral line (37–39 *vs*. 34–36). The following combination of characters distinguishes *A. douradilho* from all other species of the genus: the presence of two vertically elongate humeral spots, a conspicuous caudal spot, absence of a conspicuous dark stripe from humeral region to caudal peduncle, 3–5 maxillary tricuspid teeth, 22–24 branched anal-fin rays, 37–39 perforated scales along the lateral line, head length (26.0–29.9% SL), upper jaw length (43.8–50.6% HL), and snout length (23.0–28.6% HL).

Description. Morphometric data summarized in Table 1. Body compressed and elongate, with greatest body depth anterior to dorsal-fin origin. Dorsal profile of head straight or slightly convex. Dorsal body profile convex

from tip of supraoccipital spine to base of last dorsal-fin ray; straight from that point to adipose fin origin. Ventral profile of body convex from mandibular symphisis to pelvic fin origin, nearly straight to anal-fin origin, and posterodorsally slanted along anal-fin base. Caudal peduncle deep, nearly straight on dorsal and ventral margins.

Snout rounded from margin of upper lip to vertical through anterior nostrils. Head somewhat pointed anteriorly in lateral profile. Mouth terminal, jaw isognathous. Mouth slit nearly at horizontal through the middle of eye. Maxilla extending posteriorly to vertical through anterior margin of orbit reaching pupil. Maxilla widened anteroposteriorly.

TABLE 1. Morphometric data for holotype and paratypes of *Astyanax douradilho*, **n. sp.**, n = 30 (including holotype) from the rio Maquiné drainage, rio Tramandaí system, Rio Grande do Sul, Brazil. SD = Standard Deviation.

	Holotype	Range	Mean	SD
Standard length (mm)	90.0	48.4–90.0	65.3	–
Percents of Standard length				
Predorsal distance	52.8	52.0–57.0	54.6	1.3
Prepelvic distance	48.5	47.2–51.5	49.2	1.1
Prepectoral distance	27.4	25.8–30.2	27.8	1.0
Preanal distance	67.5	64.6–69.6	67.3	1.3
Depth at dorsal-fin origin	35.9	34.4–41.0	37.0	1.3
Caudal peduncle depth	12.4	11.6–13.4	12.3	0.4
Caudal peduncle length	12.6	9.5–14.0	11.6	1.3
Anal-fin base length	28.6	26.7–30.6	28.5	1.0
Dorsal-fin length	26.2	26.2–30.6	28.3	1.1
Pelvic-fin length	17.4	14.1–19.1	17.9	1.0
Pectoral-fin length	21.9	21.9–25.3	23.4	0.8
Head length	26.2	26.0–29.9	27.7	1.2
Percents of Head length				
Snout length	25.6	23.0–28.6	26.0	1.6
Upper jaw length	50.5	43.8–50.6	47.5	1.7
Orbital diameter	34.5	34.2–40.7	38.0	2.0
Interorbital width	28.5	22.6–30.0	27.1	1.6

Premaxillary teeth in two rows: outer row with 4(24), 5(9), or 6*(2) tricuspid teeth, central cusp longer; inner row with five teeth, gradually decreasing in length from first to fifth; usually with four cusps on first tooth, five cusps on second to fourth teeth and three cusps on fifth tooth. Maxilla with 3(27), 4*(7), or 5(2) tricuspid teeth; central cusp broader than others. Dentary with 3(2) or 4*(28) large tri- or pentacuspid teeth, followed by six to eight small teeth, uni- to tretracuspid (Fig. 2). Median cusp in all cuspidate teeth longer than remaining cusps; cusp tips slightly curved inwardly in dentary, premaxillary teeth cusps approximately straight.

Dorsal-fin rays i,9(1) or 10*(34); first unbranched ray approximately half length of second ray. Distal margin of dorsal fin nearly straight to somewhat convex. Dorsal fin origin slightly behind middle of SL. Origin of adipose fin at vertical through second or third last anal-fin rays. Anal-fin rays iii(20) or iv(16), 22(11), 23*(16), or 24(8). Anal fin origin posterior to vertical through base of last dorsal-fin ray. Pectoral-fin rays i,11(2), 12(14), 13*(14), or 14(6). Pectoral-fin tip not reaching pelvic-fin insertion. Pelvic-fin rays i,7*(36). Pelvic fin origin slightly anterior to vertical through dorsal-fin origin. Caudal fin forked, lobes similar in size, i,17,i*(34) principal rays. Dorsal procurrent rays 11(1), 12(1), or 13(1) and ventral procurrent rays 10(2) or 11(1).

Lateral line complete with 37(13), 38*(18), or 39(5) scales. Scale rows between dorsal-fin origin and lateral line 6(6) or 7*(30); scale rows between lateral line and pelvic-fin origin 5*(31) or 6(5). Predorsal scales 11(9), 12*(21) or 13(4) arranged in regular series. Scale rows around caudal peduncle 14(9), 15(11), or 16*(15). Scale sheath along anal fin base 8-15 scales (32), in single series, covering base of anteriormost rays. Axillary scale, longer than wide, relatively folded in half, and extending over 1-2 longitudinal scale series.

FIGURE 1. *Astyanax douradilho*, MCN 19858, 90.0 mm SL, holotype, arroio Encantado, rio Maquiné basin, rio Tramandaí system, municipality of Maquiné, Rio Grande do Sul State, Brazil. A) Specimen just after fixation; B) in alcohol.

Precaudal vertebrae 15(1), 16(1), or 17(1); caudal vertebrae 20(2) or 21(1); total vertebrae 36(2) or 37(1). Supraneurals 5(3). Gill-rakers upper branch 6(8) or 7(6); lower branch 11(8) or 12(6); total number 17(3), 18(10), or 19(1).

Color in alcohol. Dorsal and dorsolateral portions of head and body dark brown. Infraorbital and opercular areas covered with scattered, dark chromatophores. Scales on lateral body with dark brown chromatophores. Midlateral stripe very faint. Caudal spot black, triangular or irregular in shape, extending to tip of middle caudal-fin rays. Two humeral spots. Anterior one, conspicuous, vertically elongate with upper portion wider, located over third to fifth vertical series of scales, extending over 2 to 3 horizontal series of scales above lateral line; lower portion of spot narrow (1 to 2 scales pigmented), extending over 1 to 2 horizontal series of scales below lateral line. Second humeral spot large, occasionally faint, not surpassing lateral line ventrally, extending over 3 horizontal series and 2 to 3 vertical series of scales above lateral line. Scattered dark chromatophores on dorsal, adipose, caudal and anal fins. Pectoral and pelvic with few dark chromatophores. Dark pigmentation on middle caudal-fin rays and along median-distal portion of anal-fin rays (Fig. 1a).

Color in life. Color pattern similar to that described for alcohol preserved specimens. Overall and head color pattern yellowish, slightly brown. Dorsolateral portion of body dark gray. Scales on lateral body silvery. Dorsal, pectoral, and pelvic fins with anterior portion yellowish and posterior reddish. Anal fin reddish colored at distal half of first rays. Caudal fin almost completely reddish, except middle portion. Adipose fin yellowish (Fig. 1b).

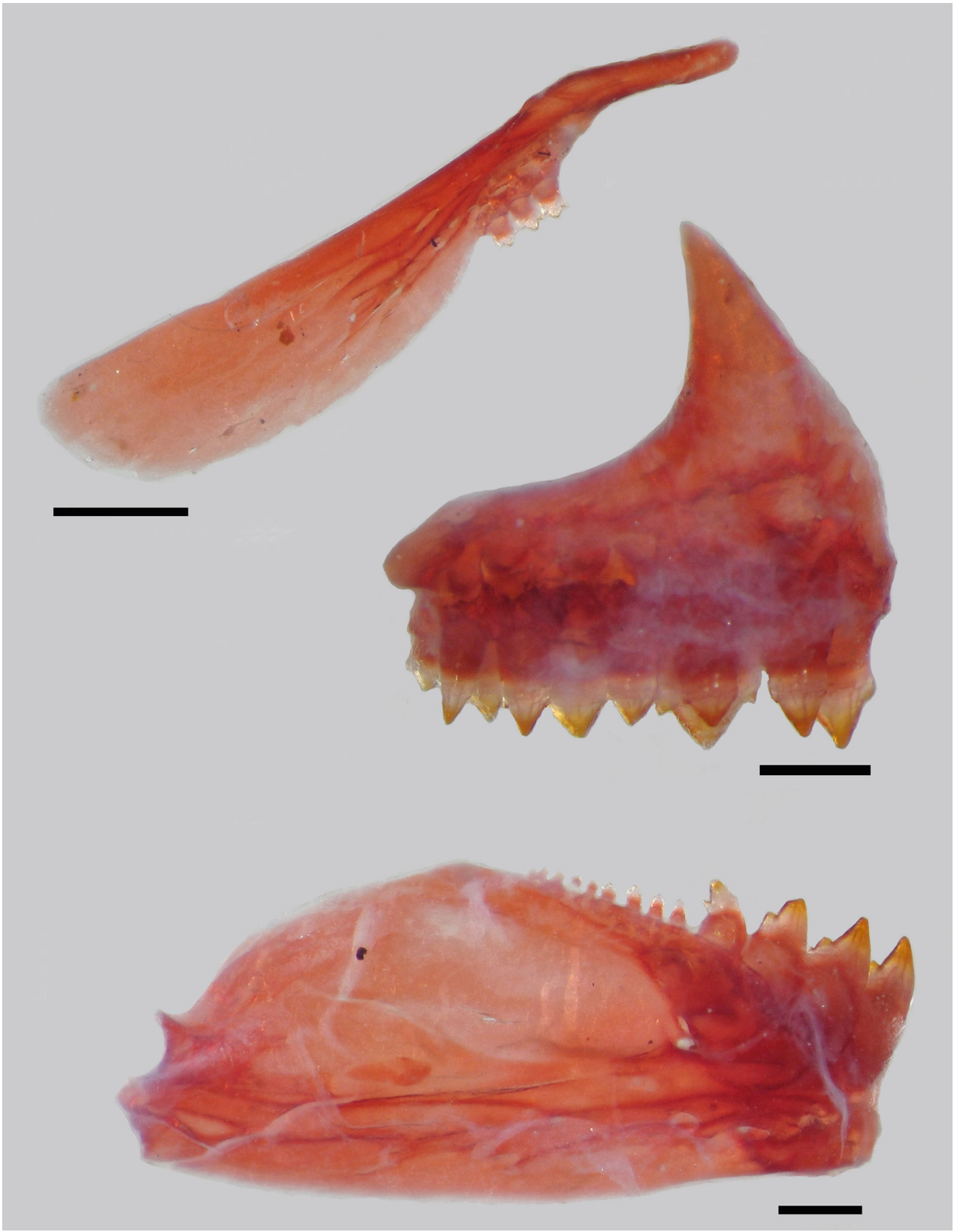

FIGURE 2. *Astyanax douradilho*, MCP 25700, 54.0 mm SL, paratype. Upper and lower jaw teeth, left side, lateral view. Scale bars = 1 mm.

Sexual dimorphism. Males with small bony hooks on dorsal-, pectoral-, pelvic- and anal-fin rays (rarely in caudal-fin). One paired bony hook per lepidotrichia in the last unbranched anal-fin ray and first to thirteenth branched anal-fin rays on median and distal portions of the rays. One paired bony hook per lepidotrichia on second to fifth branched pelvic-fin rays. Small bony hooks on distal one-third of anteriormost branched dorsal- and pectoral-fin rays, and on distal portion of middle caudal-fin rays. No other apparent sexually dimorphic features were found in the specimens examined. Gill glands (Burns & Weitzman 1996) were not found macroscopically on the first gill arch.

Distribution. *Astyanax douradilho* is known from tributaries of the rio Maquiné, rio Tramandaí system, coastal drainage of Rio Grande do Sul, southern Brazil (Fig. 3).

Etymology. Douradilho is a regional name for the horse color pattern consisting of a reddish brown or golden yellow. The name is an allusion to the color of the fins in live specimens. A noun in apposition.

Ecological notes. *Astyanax douradilho* was collected in relatively small, clear water streams until 1 m deep, with stones and rocks on bottom, and moderate riparian vegetation. The collection localities are around 300 m above sea level. In the Encantado (Fig. 4) and Lageado streams, the pH ranged from 6.5 to 6.8, conductivity between 31.7 to 39.5 µs/cm, and oxygen level between 5.0 to 6.8 mg/l. Based on examination of several lots in fish collection, the species seems to be found only in mainstream of small rivers draining from Serra Geral formation, and was not found in the other subregion basin formed by lagoons of the Coastal Plain (Malabarba & Isaia 1992).

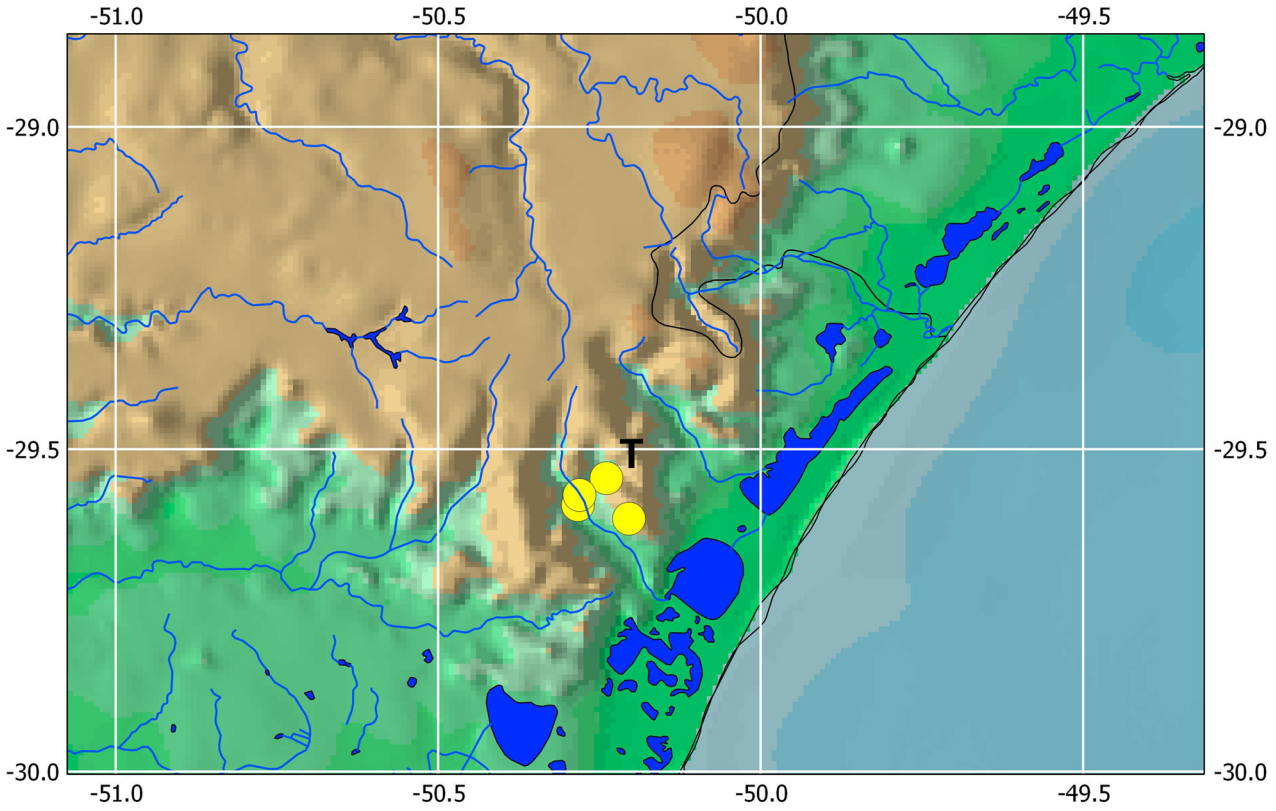

FIGURE 3. Map of southern Brazil showing the distribution of the examined material of *Astyanax douradilho*. Some symbols represent more than one lot or locality. T = type locality.

Discussion

Astyanax douradilho is herein assigned to *Astyanax* according to the definition of the genus given by Eigenmann (1921, 1927), which is still used (Lucena *et al*. 2013a,b; Oliveira *et al*. 2013) due to the absence of a cladistic definition of the genus. The new species recognized herein does not fit the definitions of the *A. bimaculatus* (*sensu* Garutti & Britski 2000) and *A. scabripinnis* (*sensu* Bertaco & Lucena 2006) species complexes.

FIGURE 4. Type locality of *Astyanax douradilho*, arroio Encantado, rio Tramandaí system, municipality of Maquiné, Rio Grande do Sul State, Brazil.

According to Mirande (2010), *Astyanax douradilho* has the synapomorphies that define node 200 (which included the *Astyanax* clade and *Astyanax paris* clade as well as Aphyocharacinae, Aphyoditeinae, Cheirodontinae, Gymnocharacinae, Stevardiinae, and *Bryconamericus scleroparius* clade): fourth infraorbital approximately square or more developed longitudinally than dorsoventrally, coronomeckelian situated mainly dorsal to Meckel cartilage, and 24, or less, branched anal-fin rays. On the other hand, *A. douradilho* partially shares the synapomorphies that define the "*Astyanax* clade" and "*Astyanax paris* clade". Although the hypothesis of Mirande (2010) is the most comprehensive phylogenetic analysis including the genus *Astyanax*, it includes only some of its species and a robust proposal including a large number of species is necessary.

In the main drainage basins of Rio Grande do Sul State 17 species of *Astyanax* are recognized (Lucena *et al*. 2013a,b; Malabarba *et al*. 2013). Among these, only six species occur in the rio Tramandaí system: *A. cremnobates* Bertaco & Malabarba, *A. dissensus* Lucena & Thofehrn, *A. laticeps*, *A. eigenmanniorum* (Cope), *Astyanax* sp. aff. *fasciatus sensu* Melo & Buckup 2006, and *A. jacuhiensis* (Cope). Only *Astyanax cremnobates*, *A. laticeps* and *A. douradilho* can be found in headwaters environments. The remaining species occur in the inferior portion of rivers and lagoons of the rio Tramandaí system. *Astyanax douradilho* differs from all these species by the absence of a conspicuous dark stripe from humeral region to caudal peduncle and by the number of maxillary teeth (3 to 4 *vs*. absence or 1 to 2), except from *A. laticeps* which differs by having two vertically elongate humeral spots *vs*. one oval horizontally elongate.

Astyanax douradilho inhabits tributaries of the rio Maquiné, a river valley of the rio Tramandaí system. Malabarba & Isaia (1992) identified the area comprising the rio Maquiné, rio Três Forquilhas, and rio Mampituba as an area of endemism of fish species, later extended to the next northern drainage of the rio Araranguá by evidence presented by Reis & Schaefer (1999). The distribution of *A. douradilho* is partially congruent with the

freshwater ecoregion Tramandaí-Mampituba as recently recognized by Abell *et al*. (2008). Although extensive collections have been made in the stream and river tributaries of the rio Tramandaí (Maquiné and Três Forquilhas rivers) and rio Mampituba basins in the last decade, *A. douradilho* was not recorded in any other locality.

According to Malabarba *et al*. (2013) the ichthyofauna of the rio Tramandaí system is divided in fish species found in the river valleys located in the Serra Geral Formation and in the lagoons of the coastal plain. *Astyanax douradilho* and at least 20 other species are restricted to the river valleys, indicating the existence of effective barriers separating these species.

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