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A new species of *Astyanax* (Characiformes: Characidae) from the rapids of the lower rio Xingu, Brazil

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Astyanax dnophos, new species, is described from the lower rio Xingu, Pará, Brazil. The new species is distinguished from its purported congeners by the presence of a broad longitudinal, midlateral dark stripe that extends from the snout to the caudal peduncle. *Astyanax dnophos* dwells on shadowed, rocky shelters on rapids, and it is apparently one of the few species of Characidae outside Serrasalminae reported to be rheophilic.

Astyanax dnophos, nova espécie, é descrita do baixo rio Xingu, Pará, Brasil. A nova espécie pode ser distinguida de suas presumíveis congêneres pela presença de uma larga faixa longitudinal escura no meio do corpo que se estende do focinho ao pedúnculo caudal. *Astyanax dnophos* habita abrigos sombreados sob rochas nas corredeiras e aparentemente é uma das poucas espécies de Characidae, excetuando Serrasalminae, citada como sendo reofílica.

Key words: rheophily, Amazon basin, taxonomy, longitudinal stripe, rocky shelter

Introduction

The genus *Astyanax* Baird & Girard is one of the most speciose within Characidae, comprising at least 86 valid species (Lima *et al*., 2003). The genus possess the widest distribution among all New World characiforms, ranging from Texas and New Mexico in United States (Page & Burr, 1991) south to the río Colorado/río Negro region in northern Patagonia, Argentina (Almirón *et al*., 1997). *Astyanax* systematics is complex and poorly known; Eigenmann's monograph on the Characidae (1921, 1927) is the single, albeit outdated, revision for the genus. The genus is very probably not monophyletic (Rosen, 1972; Weitzman & Fink, 1983; Zanata, 1997).

One of the authors (JZ) surveyed the natural history of the fishes from the rapids in the lower rio Xingu, Brazil (Zuanon, 1999). During that study a strikingly patterned, rheophilic small characid was discovered. We describe it below as a new *Astyanax* species, regarding, however, its generic assignment as temporary, pending further studies on the phylogeny of that and related genera.

Material and Methods

Counts and measurements were taken according to Fink & Weitzman (1974: 1-2) and Menezes & Weitzman (1990). In the descriptions, the frequency of each count is provided in parentheses after the respective count. An asterisk indicates counts of the holotype. Vertebrae, supraneurals, gill-rakers and most teeth counts were taken only from cleared and stained paratypes (cs), prepared according to the method of Taylor & Van Dyke (1985). Vertebrae of the Weberian apparatus were counted as four elements and the fused PU1+U1 of the caudal region as a single element. In the material listed, the number of whole specimens of the lot comes first, followed by the number of cleared and stained specimens (if any). Fish behavior in the field was observed underwater by snorkeling (*cf*. Sazima, 1986) with use of "focal animal" and "all occurrences" sampling techniques (Lehner, 1996). Current velocity was measured using a mechanical flow meter General Oceanics, model 2030R, just below the water surface.

Institutional abbreviations are: CAS, California Academy of Sciences, San Francisco; INPA, Instituto Nacional de Pesquisas da Amazônia, Manaus; MUSM, Museo de Historia Natural, Universidad Nacional Mayor de San Marcos, Lima; MZUSP, Museu de Zoologia, Universidade de São Paulo, São Paulo; UMMZ, Museum of Zoology, University of Michigan, Ann Arbor; and ZUEC, Coleção de Zoologia, Universidade Estadual de Campinas, Campinas.

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Fig. 1. *Astyanax dnophos*, holotype, INPA 22072, 31.4 mm SL: Brazil, Pará, rio Xingu.

Astyanax dnophos, new species

Figs. 1 - 2

Hemigrammus sp. "Xingu": Stawikowski, 2001: 30-31, photo ("Altamira...Balneario Pedral...unteren Rio Xingu").

Holotype. INPA 22072 (31.4 mm SL), Brazil, Pará, Altamira, rio Xingu, Costa Júnior, 03°29'37"S, 52°20'10"W; J. Zuanon, 25 Sep 1997.

Paratypes. All localities in Brazil, Pará State, rio Xingu, municípios de Altamira and Senador José Porfírio. INPA 20507 (1, 40.2 mm SL); MZUSP 84417 (1, 27.6 mm SL); same data as holotype. INPA 20516 (2, 26.3-46.7 mm SL); CAS 219762 (1, 28.5 mm SL); Costa Júnior, rapids downstream the campsite, 3°16'21"S, 52°12'07"W; J. Zuanon, 24 Sep 1997. INPA 20517 (3, 1 cs, 23.8-27.7 mm SL), Costa Júnior, 3°16'21"S, 52°12'07"W; J. Zuanon, 23 Sep 1997. INPA 20513 (3, 18.5-28.4 mm SL); MZUSP 84416 (1, 26.0 mm SL); near Ilha da Bela Vista, 3°24'22"S, 51°43'03"W; J. Zuanon, 27 Sep 1996. INPA 20510 (2, 25.8-27.6 mm SL), corredeira Arini, 3°24'15"S, 51°41'53"W; J. Zuanon, 8 Sep 1997. INPA 20505 (1, 30.0 mm SL); UMMZ 243665 (1, 25.5 mm SL); Furo do Ramiro, 3°15'21"S, 52°05'06"W; J. Zuanon, 13 Sep 1997. INPA 20512 (9, 18.6-25.9 mm SL), Sr. Izaltino Barbosa's island, 3°16'21"S, 52°12'07"W; J. Zuanon, 5 Oct 1996. INPA 20506 (4, 14.6-24.8 mm SL), pedral (rocky rapid) below Sr. Izaltino Barbosa's island, 3°16'42"S, 52°04'11"W; J. Zuanon, 14 Sep 1997. ZUEC 4482 (3, not measured), pedral (rocky rapid) below Sr. Izaltino Barbosa's island, 3°16'21"S, 52°12'07"W; J. Zuanon, 14 Sep 1997. MZUSP 82460 (3, 1cs, 29.6-33.2 mm SL), Belo Monte, rocky pool, near the rapids, 3°05'S, 51°46'W; M. Goulding, 26 Sep 1983.

Diagnosis. *Astyanax dnophos* can be distinguished from its purported congeners by the presence of a dark, broad, midlateral stripe extending from the snout to the caudal-fin base, formed by superficial pigmentation (*vs*. dark midlateral stripe, when present, relatively narrow, not extending onto head, and formed by subjacent pigmentation, being only apparent in specimens stored for a relatively long period in formalin (see Lima & Toledo-Piza, 2001). Useful characters that might help to tell apart the new species from other small characids are a long anal fin, with 24-26 branched rays, and a large eye (43.0-49.4 % in head length).

Description. Morphometric data of holotype and paratypes presented in Table 1. Body compressed, moderately slender, greatest body depth at dorsal-fin origin. Dorsal profile of head convex from upper lip to vertical through middle of orbit; slightly concave from latter point to tip of supraoccipital spine. Predorsal profile of body slightly convex**,** dorsal-fin base posteroventrally inclined, straight. Body profile straight from end of base of dorsal fin to adipose fin; slightly concave between latter point and origin of dorsalmost procurrent caudal-fin ray. Ventral profile of head and body convex from lower lip to anal-fin origin. Body profile along anal-fin base straight, posterodorsally slanted. Ventral profile of caudal peduncle slightly concave.

Jaws equal, mouth terminal. Maxilla reaching vertical through anterior margin of orbit. Premaxillary teeth in two rows (Fig. 4). Outer row with 2(1), 3*(7), 4(13), or 5(4) tricuspid teeth. Inner row with 5 tetra- to pentacuspid teeth. Maxilla with 5 or 6(2) tri- to tetracuspid teeth. Dentary with 4 large, penta- to heptacuspid teeth followed by 11-12(2) smaller uni- to tricuspid teeth (Fig. 3).

Scales cycloid, circuli present on exposed area of scales, with few slightly divergent radii extending to posterior margin of scales. Lateral line complete, with 32(1), 33(2), 34(1), 35*(9), 36(5), or 37(6) perforated scales. Horizontal scale rows between dorsal-fin origin and lateral line 5, not including scale of predorsal series situated just anterior to first dorsal-fin ray. Horizontal scale rows between lateral line and pelvic-fin insertion 4. Predorsal scales 7(2), 8(14), 9*(3), or 10(1). Circumpeduncular scales 12(5), 13(5), or 14*(3). Single row of 10-12 scales covering base of anteriormost anal-fin rays.

Dorsal-fin rays typically ii,9 (ii,10 in one specimen). Dorsal-fin origin slightly anterior to middle of standard length. Base of last dorsal-fin ray at vertical through anal-fin origin. First dorsal-fin pterygiophore inserting behind neural spine of 8th(2) vertebra. Adipose fin present. Anal-fin rays iii(8) or iv*(17), 24(8), 25(11), or 26*(6). First anal-fin pterygiophore inserting behind hemal spine of 15th(2) vertebra**.** Pectoral-fin rays i,12(6), 13(14), 14(2), or 15*(3). Tip of pectoral fin reaching vertical through pelvic-fin insertion. Pelvic-fin rays i,7. Caudal fin forked, lobes slightly pointed, similar in size. Principal caudal-fin rays 10+9(2). Twelve (1), or 13(1) dorsal procurrent caudal-fin rays, and 10(1), or 11(1) ventral procurrent caudal-fin rays. First gill arch with 7(1), or 9(1) epibranchial, 8(1), or 9(1) ceratobranchial, 1(2) on cartilage between ceratobranchial and epibranchial, and 2(2) hypobranchial gill-rakers. Four (2) branchiostegal rays, 3(2) on anterior ceratohyal, and 1(2) on posterior ceratohyal. Vertebrae 34(2). Supraneurals 4(2).

Color in alcohol. Overall color light beige. Some specimens still retaining guanine on opercle, infraorbitals, and sides of body. Dark chromatophores densely concentrated on dorsal surface of head, anterior surface of lower jaw, and maxilla. Numerous relatively large dark chromatophores on infraorbitals and opercle. Longitudinal dark stripe, wide as the iris, across the eye. Two longitudinal dark stripes on trunk: one dorsal, light brown, formed by relatively small dark chromatophores, continuous with dark pigmentation at top of head and extending to upper surface of caudal peduncle. Second stripe dark, mid-lateral, broad (about as wide as eye), continuous with dark pigmentation on snout, eye, infraorbitals, and opercle, formed by relatively large dark chromatophores. Dorsal margin of stripe relatively straight, lower margin slightly concave anteriorly, tapering towards caudal peduncle. Humeral spot present, merged into midlateral stripe, just perceptible as darker area with superior extension into light area intermediate to both stripes. Light area between dorsal and midlateral stripes, and below midlateral stripes, with few, scattered dark chromatophores, except for small concentration on base of anteriormost anal fin rays. Dark pigmentation on basal portions of medial caudal-fin rays, continuous with dark midlateral stripe. Scattered dark chromatophores on anal, dorsal, adipose, and caudal fins. Pectoral and pelvic fins with few dark chromatophores. Anal-fin base with narrow, dark area (lacking in clear-colored specimens). Color intensity variable among paratypes, some small specimens (*e.g.*, INPA 20510, 20512) much clearer, which apparently is related to the degree of chromatophore contraction immediately before preservation.

Color in life. Description based on specimens photographed in field aquaria just after capture (see Fig. 2; *cf*. also Stawikowski, 2001:31). Dorsal region from above eye to origin of adipose fin gray to brownish. Cream to whitish colored narrow stripe running from postorbital region to base of caudal fin, with second narrow iridescent yellow stripe just below and parallel to it. Humeral spot barely visible as darker, greenish area over anterior portion of iridescent lateral stripe. Broad black mid lateral band running from snout and across eye to caudal fin base. Eye with upper third of iris iridescent greenish yellow to bronze colored. Ventral region from gular area through region above anal fin base and lower portion of caudal peduncle light beige. Concentration of chromatophores forming dark area above anterior portion of anal-fin base. Pectoral and pelvic fins yellow; two or three anteriormost dorsal-fin rays and basal portions of caudal and anal fin with yellowish tint.

Geographic distribution. *Astyanax dnophos* is only known from the lower rio Xingu, in the region of Altamira, Pará, Brazil.

Ecological notes. Groups of up to a hundred individuals of *A. dnophos* were observed in rapid areas with rocky bottom and moderate to fast current (0.40 – 1.5 m.s^{-1}). Although occasionally seen foraging on open water near the bottom in

Fig. 2. *Astyanax dnophos*, paratype, INPA 20505, 30.0 mm SL: Brazil, Pará, rio Xingu; in life.

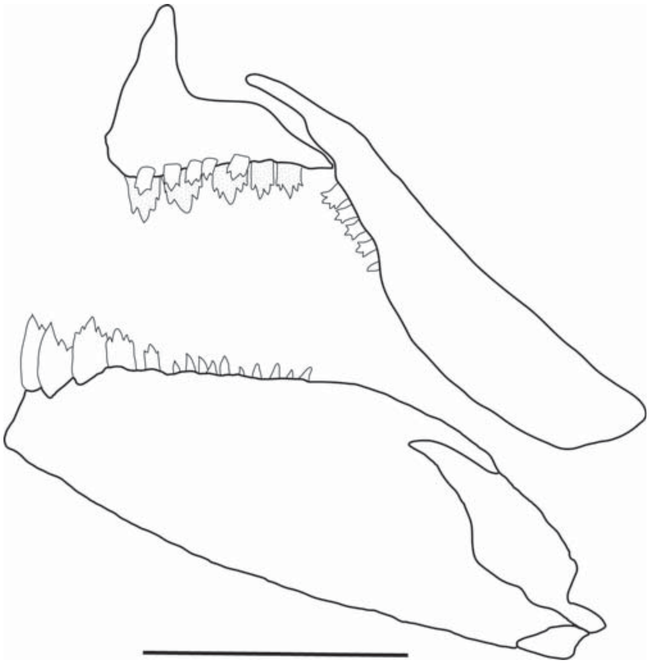

Fig. 3. *Astyanax dnophos*, paratype, MZUSP 82460, 29.6 mm SL. Upper and lower jaws, lateral view, left side. Scale bar: 1 mm.

shallow riffles, most of the fish groups were found in dark, shadowed shelters among large rocks or under boulders in river stretches up to 2 m deep. The fish were seen swimming in loose groups protected from direct current in the shelter and foraging on drifting and stirred up particles in the water column. In these low light conditions, the fish's iridescent lateral stripe and the bright upper portion of the iris outstands against the dark background. The large eyes characteristic of this species may be related to the low light conditions in these shelters and to the supposedly visually oriented drift feeding strategy displayed by *A. dnophos*.

Etymology. From the Greek *dnophos*, darkness, gloom, in allusion to the habitat occupied by the new species.

Discussion

The present generic assignment of *Astyanax dnophos* must be regarded as tentative. Most *Astyanax* species, including *Astyanax mexicanus* (De Filippi), the type-species, are mid-sized tetras (size at maturity ranging from 60 to 160 mm SL), possessing red or yellow colored fins in life, a dark midlateral stripe on caudal peduncle, and a single, conspicuous humeral spot. Consequently, they do not resemble closely *A. dnophos* in overall external morphology. However, in the classificatory system for the so-called Tetragonopterinae established by Eigenmann (1917), which is still in use, the characters that delimit *Astyanax*, *i.e.*, the presence of a complete lateral line, the lack of scales on the caudal-fin basis, and the presence of five teeth on the inner row of the premaxillary, are all shared by the new species. The alternative option, the erection of a monotypic genus to accommodate the new species, does not appear warranted since the single character that unequivocally diagnoses *A. dnophos* from its congeners, the striped color pattern, is putatively autapomorphic and thus not informative about relationships within Characidae. In view that a comprehensive hypothesis on the relationships within the Characidae is still lacking, we believe that the inclusion of the new species into *Astyanax* is, for the time being, the best option available.

Among small characids, *Astyanax dnophos* shares with some *Hyphessobrycon* species (those pertaining to the "*Hyphessobrycon agulha*" and "*Hyphessobrycon heterorhabdus*" species-groups; Géry, 1977), *Inpaichthys kerri* Géry & Junk, *Moenkhausia phaeonota* Fink, *Tucanoichthys tucano* Géry & Römer, and both *Nematobrycon* species the presence of a variously developed, but always conspicuous and superficial, midlateral dark stripe. Without implying in considering as homologous color patterns that differ in some details, we can however characterize these stripes in the following broad categories: narrow and straight (some *Hyphessobrycon* species, *e.g.*, *H. vilmae* Géry, *H. heterorhabdus* (Ulrey), *H. cachimbensis* Travassos, *H. stegemanni* Géry, and *H. scholzei* Ahl), broad and straight (*H. agulha* Fowler, *H. loretoensis* Ladiges, *H. metae* Eigenmann & Henn, *H. peruvianus* Ladiges, *H. herbertaxelrodi* Géry, *Tucanoichthys tucano*, *Moenkhausia phaeonota*, and *Astyanax dnophos*), or broad and curve (*Inpaichthys kerri* and *Nematobrycon* spp.). Apart from this superficial similarity in color pattern, no other character was found that could suggest a close relationship between *A. dnophos* to any of the aforementioned taxa.

Rheophily is known among South American freshwater fishes in Anostomidae (Santos & Jégu, 1987; Santos *et al*., 1996), Crenuchidae (Buckup, 1993), Characidae (subfamily Serrasalminae: Jégu & Santos, 1988; Jégu, 1992; Jégu *et al*., 1992; Jégu & Santos, 2002; Jégu *et al*., 2002a; Jégu *et al*., 2002b), Sternopygidae (Schwassmann & Carvalho, 1985), Batrachoididae (Collette, 1995), and Cichlidae (Kullander, 1988; Zuanon & Sazima, 2002). Many Loricariidae are also obviously rheophilic (*e.g.*, Zuanon, 1999). *Astyanax dnophos* is probably one of a few species among Characidae outside Serrasalminae in its habitat preferences, but apparently has no special morphological adaptations to this habit other than perhaps the eye size and the color pattern. Adaptation to the life in rapids, in this case, is essentially behavioral (*i.e.*, the habit of swimming sheltered from direct current). Both *Hypobrycon* species occurring in southern Brazil are also specialized riffle-dwelling characids (L.R. Malabarba, pers.comm.). Casatti & Castro (1998) also recorded some morphologically generalized characid species (q.v., *Bryconamericus stramineus* Eigenmann, *Bryconamericus* sp., and *Astyanax rivularis* (Lütken)) inhabiting rapids at rio São Francisco in southeastern Brazil that apparently relied on behavioral adaptations to occupy fast flowing river stretches. Nevertheless, differently from *A. dnophos*, these species seems to occur in a variety of river and stream habitats. As the remaining rheophilic fishes inhabiting the lower course of the rio Xingu, *A. dnophos* faces an uncertain future in view of the plans held by the Brazilian government of building a huge dam, Belo Monte, at this site.

Comparative material examined: *Inpaichthys kerri*: INPA 10408, holotype; INPA 10410, 4; INPA 10411, 1; INPA 10412, 2; INPA 10413, 2; paratypes. *Hyphessobrycon cf. agulha*: MZUSP 81397, 28. *H. herbertaxelrodi*: MZUSP 25242, 13. *H. heterorhabdus*: MZUSP 42813, 15. *H. loretoensis*: MUSM uncat., 41. *H. peruvianus*: MUSM uncat., 11. *H. cf. stegemanni*: MZUSP 47846, 357. *H. vilmae*: MZUSP 61128, 87. *Moenkhausia phaeonota*: MZUSP 45301, 193, 2 cs. *Nematobrycon palmeri*: MZUSP 62432, 1. *Tucanoichthys tucano*: MZUSP 51321, holotype; MZUSP 51322, 10, paratypes.

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