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Apteronotus acidops, new species of long snouted electric fish (Teleostei: Gymnotiformes: Apteronotidae) from the upper rio Paraná basin in Brazil, with a key to the apteronotid species from the area

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> Abstract

Apteronotus acidops, new species, is described from the upper Paraná River basin, Brazil. It can be diagnosed from the remaining species of the genus by the following combination of characters: dorsal snout profile pointed; snout length 46.4–63.7 % of head length; oculo-nasal distance 39.2–72.1 % of postocular distance; lateral ethmoid with both dorsal and ventral extremities expanded, strongly oblique in orientation; mouth rictus surpassing vertical through anterior eye margin, including its skin folds, in all ages; dorsal head profile nearly horizontal from a vertical through anus to posterior extremity of occipital bone; absence of mid-dorsal white or clear stripe on head and body anteriorly; chin brown; upper lip clear to a vertical through anterior nostril; transversal unpigmented bar or bars posteriorly on the body absent; flanks brown, darker dorsally and pectoral fin hyaline, with chromatophores over rays. Moreover, a key for the apteronotid species from the upper rio Paraná is provided.

> Resumo

Apteronotus acidops, espécie nova, é descrita da bacia do alto rio Paraná, Brasil. Ela pode ser diagnosticada das demais espécies do gênero pela seguinte combinação de caracteres: perfil dorsal do focinho afilado; comprimento do focinho 46.4–63.7 % do comprimento cefálico; distância óculo-nasal 39.2–72.1 % da distância pós-ocular; etmóide lateral com ambas as extremidades expandidas, e de orientação fortemente oblíqua; abertura bucal ultrapassando uma vertical pela margem ocular anterior, incluindo suas dobras de pele, em todas as idades; perfil cefálico dorsal quase horizontal, desde uma vertical pelo anus até a extremidade posterior do osso supra-occipital; ausência de faixa mediana dorsal clara ou branca na cabeça e corpo, anteriormente; mento castanho; lábio superior claro até uma vertical pela narina anterior; ausência de barras transversais despigmentadas, posteriormente no corpo; flancos castanhos, mais escuros dorsalmente, e nadadeiras peitorais hialinas, com cromatóforos sobre os raios. Além disso, uma chave para as espécies de apteronotídeos da bacia do alto rio Paraná é apresentada.

> Key words

Freshwaters, Morphology, Neotropical Region, Ostariophysi, Pisces, South American electric fish, Taxonomy.

Introduction

Currently, 22 species are considered valid in the genus *Apteronotus* La Cepède, 1800 (Froese & Pauly, 2011), although *A. ellisi* (Arámburu, 1957) and *A. marauna* (Triques, 1998) have been described and considered valid in other genera (*e.g.* Campos-da-Paz, 2005; Da Graça & Pavanelli, 2007; Triques, 2005). The Ilha Solteira Power Plant was built in the rio Paraná, between the states of São Paulo and Mato Grosso do Sul. In its coffer dam, in 1965, specimens of an unidentified species of *Apteronotus* were col-

lected. Additional specimens of the same species were collected in the rio Mogi-Guaçu at rio Pardo drainage, rio Paraná basin in the state of São Paulo, Brazil. The species resembles *A. brasiliensis* (REINHARDT, 1852), from the rio São Francisco and rio Paraná basins and *A. leptorhynchus* (ELLIS, 1912) from the Guyanas and río Orinoco basins, in general morphology (differing clearly from this last species by the absence of a clear mid-dorsal stripe on head and anterior region of body, in the new species). *Apteronotus brasiliensis* is known to occur in the same area but skeletal and external morphology differences were found among them. Differences were also found from every other *Apteronotus* species. Furthermore, the new species clearly can not be included in any other long snouted genus of the family and is placed in *Apteronotus*.

Material and Methods

Measurements and counts were made as in TRIQUES (1996), together with the "length to the end of anal fin" (LEA), that is, the length from the anterior tip of snout to the base of the last anal-fin ray.

Comparisons with already known valid species were made on the basis of original descriptions and other information present on literature (mentioned in the comparative diagnosis) and/or with comparative material (presented in the comparative material list). *Apteronotus brasiliensis* is morphologically similar to the new species, both occurring in Rio Paraná basin and presents the same color pattern of the new species, therefore skeletal differences were presented to differ both species more conclusively. Thus, five specimens of *A. brasiliensis* and one of the new species were cleared and stained for bone and cartilage (annotated as C&S), according to TAYLOR & VAN DYKE (1985) and dissected according to WEITZMAN (1974). Institutional acronyms follow LEVITON *et al*. (1985) with the addition of DZUFMG for Departamento de Zoologia da Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais State, Brazil. For sexual dimorphism evaluation, permission for dissection to sexual identification was requested, and obtained for seven specimens, including the holotype; data expressed on type material presentation included head and snout lengths only for holotype and a few sexed specimens. Although there are some proposals of species subgroups for *Apteronotus*, they are not consensual (*e.g*. ALBERT, 2003; TRIQUES, 2005) and therefore a comprehensive diagnosis seems to be preferable and was thus made.

Apteronotus acidops spec. nov.

Figs. 1 – 3, Table 1

Holotype. MZUSP 45685, (321 mm LEA; head 72.8 mm; snout 41.1; male), Brazil, rio Paraná at Ilha Solteira, 20° 30' S 51° 0W, between states of São Paulo and Mato Grosso do Sul, September 1965, Expedition of Departamento de Zoologia da Universidade de São Paulo.

Paratypes. MZUSP 23094, (09: 156 – 321 mm LEA, 1 C&S; female with 174.0 mm LEA, head 35.3, snout 17.3; male with 224.0 mm SL, head 47.3 mm, snout 25.7 mm; two males with missing tails, heads 42.4 – 57.8, snouts 23.5 – 36.8 mm) collected with holotype. MZUSP 24463, (11: 90 – 143 mm LEA), Brazil, right margin of rio Paraná at Ilha Solteira, 20° 30' S 51° 0'W W, State of Mato Grosso do Sul, 25 – 28 May 1972, Expedition of Departamento de Zoologia da Universidade de São Paulo. MZUSP 22944, (1: 157 mm LEA), Brazil, Mogi-Guaçu River (near to Emas falls), tributary of rio Pardo, tributary of rio Grande, left bank tributary of rio Paraná, Pirassununga, state of São Paulo, February 1964, R. KLOSO. MZUSP 2646, (1: 235 mm LEA, head 45.9 mm, snout 23.8 mm; sex undetermined), rio Mogi-Guaçu (near to Emas falls), tributary of rio Pardo, tributary of rio Grande, left bank tributary of Rio Paraná, Pirassununga, state of São Paulo, January 1908, C. A. OLIVEIRA. DZUFMG 040, (1: 160 mm LEA), Brazil, rio Mogi-Guaçu, tributary of rio Pardo, tributary of Rio Grande, left bank tributary of rio Paraná, state of São Paulo, between municipalities of Araraquara and Ribeirão Preto, 1984, Paulo Venere. **Remarks**: from MZUSP 23094, two specimens are on loan to Universidad Central de Venezuela, and were not included in type series.

Diagnosis. *Apteronotus acidops* is mostly similar to *A. brasiliensis* and sympatric to it, differing by the snout length being 46.4 – 63.7% of head length (*vs*. 42,8 – 48,5% in *A. brasiliensis*, n = 11 specimens, including males and females of rather large size, 290 – 398 mm LEA; Fig. 4); oculo-nasal distance 39.2 – 72.1% of postocular distance (*vs*. 30.7 – 45.0% in *A. brasiliensis*, n = 11 specimens); lateral ethmoid with both dorsal and ventral extremities expanded, strongly oblique in orientation (*vs*. expanded dorsally and pointed ventrally, vertically oriented in *A. brasiliensis*); mouth rictus surpassing vertical through anterior eye margin, in all ages (*vs*. not reaching a vertical through anterior eye margin, usually attaining a vertical between posterior nostril and eye in *A. brasiliensis*); snout dorsal profile straight, pointed (*vs*. convex in *A. brasiliensis*; Fig. 4). *Apteronotus acidops* can be diagnosed from the other species of the genus with the following combination of characters: absence of white or clear stripe from snout tip backward to nearly the middle of body length or origin of fleshy dorsal filament (*vs*. presence of this stripe in *A. albifrons* [LINNAEUS, 1766], *A. bonapartii* [CASTELNAU, 1855], *A. cuchillejo* SCHULTZ [1949], *A. cuchillo* SCHULTZ [1949], *A. galvisi* DE SANTANA, MALDONADO-OCAMPO & CRAMPTON [2007], *A. leptorhynchus*, *A. rostratus*, *A. spurrelli* [REGAN, 1914]);

Table 1. Morphometric data of holotype and paratypes of *Apteronotus acidops*. N indicates number of measured paratypes.

	Holotype	N	paratypes
Percents of head length			
Snout length	56.4	12	46.4 – 63.7
Percents of postocular length			
Interocular width	29.9	12	24.6 – 38.0
Internasal distance 1 (between anterior nostrils)	11.1	12	13.3 – 24.0
Internasal distance 2 (between posterior nostrils)	19.4	12	18.4 – 26.6
Internasal distance 3 (between anterior and posterior nostrils)	24.3	12	22.8 – 32.1
Postocular width	50.7	11	44.0 – 57.0
Opercular width	72.9	12	70.9 – 79.0
Ocular diameter	13.2	12	8.2 – 19.0
Oculo-nasal distance (between posterior nostril and eye)	47.2	12	39.2 – 72.1
Preocular depth	74.3	12	67.1 – 83.5
Oculo-anal distance	107.6	12	90.5 – 116.6
Body width	46.5	6	31.9 – 49.8
Percents of length to end of anal fin (LEA)			
Head	21.7	09	18.4 – 26.6
Total length	126.1	07	118.4 – 124.4
Preanal distance	18.1	09	15.6 – 19.2
Prepectoral distance	24.0	08	8.2 – 19.0
Percents of anal-fin base length			
Body width	4.2	9	4.7 – 6.6

chin brown (*vs*. clear in *A. albifrons*, *A. leptorhynchus*, *A. cuchillo*, *A. magoi* de Santana, Castillo & Taphorn [2006]); transversal unpigmented bar or bars posteriorly on the body absent (*vs*. present in *A. albifrons*, *A. camposdapazi* de Santana & Lehmann [2006], *A. caudimaculosus* de Santana [2003], *A. cuchillo*, *A. eschmeyeri* de Santana, Maldonado-Ocampo, Severi & Mendes [2004], *A. galvisi*); flanks brown, darker dorsally (*vs*. ground color light brown with black dots throughout body length in *A. magdalenensis* [Miles, 1945], *A. milesi* and *A. cuchillo*; caudal peduncle with ground color clear with several dark marks in *A. magoi*); pectoral fin hyaline, with chromatophores over rays (*vs*. an hyaline stripe on the base of the pectoral fin, otherwise black in *A. jurubidae* [Fowler,1944]); dorsal snout profile pointed (*vs*. snout profile roundish in *A. apurensis* Fernández-Yepes, 1968, *A. macrolepis* [Steindachner, 1881] and *A. rostratus* [Meek & Hildebrand, 1913], head dorsal profile convex in *A. mariae* [Eigenmann & Fisher, 1914] see Mago-Leccia, 1994).

Description. Morphometric data are in table 1. Head and body elongated, strongly compressed. Body uniformly covered with cycloid scales, with decreasing sizes from lateral line series of scales, upward and downward, which are three times smaller; lateral line scales vertically elongated; dorsal and ventral scales circular; lateral line complete, to base of caudal fin, but not entering it; mid-dorsal body line covered with scales visible through skin, not organized into straight series; head, pectoral and anal fins naked; caudal fin with circular scales, slightly elongated horizontally; approximately 14 rows of scales above lateral line through a vertical passing by the posterior end of body cavity. Dorsal body profile straight, backward sloping ventrally. Ventral body profile approximately straight. Dorsal and ventral body profiles converge posteriorly, ending in a compressed caudal peduncle, with a circular or lanceolated caudal fin. Pectoral fins with i + 13 – 18 rays, anterior margin convex, posterior border straight. Anal fin with 162 – 220 rays, its origin in a vertical through middle of opercle. Opercular aperture straight or curve, its concavity backward; inferior limit at inferior level of pectoral-fin base.

Head dorsal profile sloping strongly upward and backward, from the anterior extremity of snout to a little before a vertical through anus, straight or with a very slight concavity over posterior nostril; then horizontal and slightly convex to osseous mid-dorsal border of head. Mouth terminal, with lower jaw included in upper jaw only laterally; upper lip profile usually convex, sometimes in an obtuse angle. Mentonian lateral lobe present, completely inside mouth when mouth closed, backward elongated to a point through vertical by anterior nostril. Premaxillary with 8 – 11 elongated, backward directed teeth, not organized

Fig. 1. *Apteronotus acidops*, holotype, lateral view, MZUSP 45685, 321 mm LEA, rio Paraná, Brazil. Scale bar = 1 cm.

Fig. 2. *Apteronotus acidops*, holotype, lateral view of head, MZUSP 45685, 321 mm LEA, rio Paraná, Brazil. Scale bar = 1 cm.

spatially. Dentary with two series of elongated teeth, backward directed. Anterior nostril tubular, distant from anterior extremity of snout about two eye diameters, and from nearest upper lip margin about a little more than two eye diameters; antero-dorsally with one lateral line pore and postero-dorsally with another one; distant from posterior nostril about a little less (small specimens) or a little more (largest specimens) than two eye diameters. Posterior nostril slit like, horizontally elongated, shorter than anterior nostril aperture. Mouth rictus wide, with external skin folds that surpass vertical through most anterior eye margin (Fig. 2). Eye small, dorso-laterally on head, uniformly covered by head skin; ocular diameter roughly five times (smallest specimens) to two times (largest ones) longer than length of posterior nostril aperture.

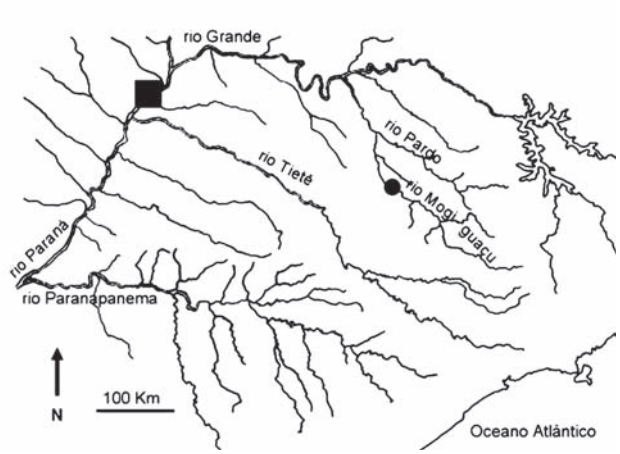

Fig. 3. Simplified map of part of upper rio Paraná basin. Square shows type locality (holotype and most paratypes) of *Apteronotus acidops*, 20° 30' S 51° 0' W. Circle indicates locality of independently collected paratype, about 23° 50' S 48° W. Geographic north indicated with an arrow.

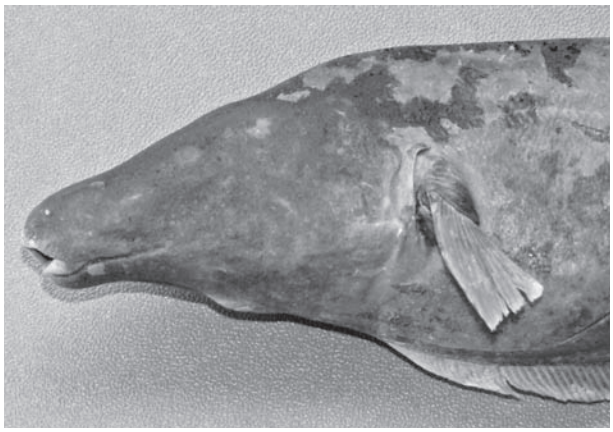

Fig. 4. *Apteronotus brasiliensis*, lateral view of head, MZUSP 23096, male, 396 mm LEA, Rio Paraná, Brazil. Photographed on right side and reversed.

Color in alcohol. Head and body brown, darker dorsally; unpigmented spot on base of caudal fin; pectoral fin and anal fin hyaline, with chromatophores over rays; caudal fin dark brown, with chromatophores over rays and membrane.

Distribution. *Apteronotus acidops* is only known from the upper rio Paraná basin (Fig. 3).

Secondary sexual dimorphism. Unknown.

Etymology. The latinized epithet "acidops" is compounded by the Greek words "akidos" meaning "point" and "ops" meaning "face", referring to the very elongated and pointed head morphology of the species.

Vernacular names. Local names are "sarapó" and "boca rachada" (Travassos, 1960: 15).

Discussion

Apteronotus acidops is promptly distinguishable from all other *Apteronotus* species – except the sympatric *A.br asiliensis* – by means of color pattern features and/or snout profile, all external and evident characters. However, as no color pattern difference was found with *A. brasiliensis* and the presence of secondary sexual dimorphism was described for some species of the genus, a deeper analysis was required in order to differenciate these two species.

Studied specimens of *A. acidops* range in size from 90 to 321 mm LEA and its snout is longer than in *A. brasiliensis*, with studied males and females of about 400 mm LEA. Therefore, it is not possible to correlate the studied material of *A. acidops* with terminal males of *A. brasiliensis*. Lateral ethmoid characteristics distinguish both species clearly. Permission was obtained to clear and stain one paratype of *A. acidops* and four of *A. brasiliensis*, covering widely the distribution of this last species in rio Paraná drainage: rio Piracicaba in São Paulo state (MZUSP 22237), Ilha Solteira in rio Paraná (MZUSP 24460), río Araguari in Minas Gerais state (DZUFMG 068) and rio São Marcos at Serra do Facão, Goiás state (DZUFMG 091), all of them with the same state for *A. brasiliensis* (expanded dorsally and pointed ventrally, vertically oriented vs. with both dorsal and ventral extremities expanded and strongly oblique orientation in *A. acidops*). Other diagnostic characters concerning to *A. brasiliensis* regard to snout profile and mouth rictus, so that all diagnostic characters between these two species are not correlated in nature among each other.

No other apteronotid species from Rio Paraná basin has the snout length as 46.4–63.7% of head length, except for *Sternarchorhynchus britiskii* Campos-da-Paz, 2000 that in turn has a downward curved snout, prolonged below a horizontal through anal fin base (*vs*. snout elongated and straight, downward directed, not surpassing a horizontal through anal fin base in *A. acidops*). *Tembeassu marauna* Triques, 1998 (*Apteronotus marauna* in Albert, 2003) has mentonian lateral lobe extremely developed, and the upper jaw presents concave profile to fit it (*vs*. mentonian lateral lobe small and upper jaw profile straight in *A. acidops*). For a description and evolutionary interpretation of this feature, see

TRIQUES (1998, 2005). *Porotergus ellisi* (*Apteronotus ellisi* in ALBERT, 2003) has snout profile roundish anteriorly; does not have scales behind the head through an extension about at least three eye diameters, from where it appears one scale row in each side of the mid-dorsal line of body, up to the insertion of the fleshy dorsal filament; in large specimens, the head dorsal profile behind the anterior nostril is horizontal and roughly contiguous with the dorsal body profile (*vs*. snout long and pointed; scales present dorsally on body, irregularly distributed [not forming clearly aligned rows], from the supraoccipital to the insertion of the fleshy dorsal filament; head dorsal profile strongly downward directed in all ontogenetic stages in *A. acidops*). *Apteronotus caudimaculosus* and *A.* aff. *albifrons* have been cited to upper rio Paraná basin (DA GRAÇA & PAVANELLI, 2007) and differ from *A. acidops* by its black body and fins, with a transversal clear band close to the level of end of anal fin, whitish stripe mid-dorsally on head and body and snout roundish anteriorly (*vs*. body brown, darker dorsally without transversal posterior band or whitish stripe mid-dorsally on head and body and snout pointed). *Sternarchella curvioperculata* GODOY, 1968, has short snout; a skin fold around the maxillary region and inferior limit of opercular opening in an imaginary horizontal through upper margin of pectoral-fin base (TRIQUES 2005: 140) (*vs*. snout long, without skin fold over the maxillary region and inferior limit of opercular opening in an imaginary horizontal through inferior margin of pectoral-fin base in *A. acidops*). *Apteronotus brasiliensis* presents snout convex to vertical through posterior nostril and does not present skin folds from mouth rictus that reach vertical through anterior eye margin (*vs*. pointed snout and presence of skin folds from mouth rictus that reach or surpass vertical through anterior eye margin in *A. acidops*).

Comparative material. Specimens for comparative studies are presented below and include species name, institutional acronym and number, number of specimens between parentheses, country and basin (when available); cleared and stained specimens are indicated as C&S.

Apteronotus albifrons: MZUSP 30082, (3, 2 C&S), Brazil, Amazon basin. *Apteronotus apurensis*: MBUCV 19931, (2, 1 C&S), Venezuela. *Apteronotus* aff. *bonapartii*: MZUSP JGL 93–155, (2, 1 C&S), Brazil, Amazon basin. *Apteronotus brasiliensis*: MZUSP 23096, (4), Brazil, rio Paraná basin, MZUSP 39954,(1), Brazil, Paraná River basin, MZUSP 22237, (4, 1 C&S), Brazil, rio Paraná basin, MZUSP 39659, (1), Brazil, rio São Francisco basin, MZUSP 39605, (2), Brazil, rio São Francisco basin, MZUSP 24460, (9, 1 C&), Brazil, rio Paraná basin, MZUSP 51505, (1), Brazil, rio São Francisco basin, DZUFMG 068, (2, 01 C&S), Brazil, rio Paraná basin, DZUFMG 046, (1), Brazil, rio Paraná basin, DZUFMG 091, (01 C&S), Brazil, rio Paraná basin. *Apteronotus cuchillejo*: USNM 121601, (2 paratypes), Venezuela, río Motatán. *Apteronotus cuchillo*: USNM 121590, (4 paratypes), Venezuela, río Apon, Maracaibo basin. *Apteronotus jurubidae*: ANSP 71435, (holotype), Colombia, rio Jurubidá. *Apteronotus leptorhynchus*: UMMZ 145761, (5, 1 C&S), Colombia, Rio Meta basin.

Key for the apteronotid species from the upper rio Paraná basin

A Head and body black, with whitish transversal band posteriorly on body ..... **G**

AA Other head and body color patterns ..... **B**

B Tube-like, downward curved snout, its anterior tip passing below horizontal line through anal-fin base ..... ***Sternarchorhynchus britskii***

BB Snout with other shapes, if tube-like, neither curve nor passing below horizontal line through anal-fin base ..... **C**

C Upper lip concave anteriorly to fit the enlarged lateral mentonian lobe .... ***Tembeassu marauna***

CC Upper lip straight or slightly convex; lateral mentonian lobe restricted to a small skin flap or fold laterally on chin, usually overlapped completely by upper lip when the mouth is closed **D**

D Skin fold as a groove encircling part of the maxillary bone region ..... ***Sternarchella curvioperculata***

DD Skin fold as a groove absent from the maxillary region ..... **E**

E Snout broad anteriorly, its profile up to a vertical through posterior nostril, circular ..... ***Porotergus ellisi***

EE Snout tubular, not circular in profile up to a vertical through posterior nostril ..... **F**

F Mouth gape surpassing vertical through anterior eye margin; snout dorsal profile straight, pointed; lateral ethmoid with both dorsal and ventral extremities expanded, strongly oblique in orientation ..... ***Apteronotus acidops* spec. nov.**

FF Mouth gape not reaching a vertical through anterior eye margin, usually attaining a vertical between posterior nostril and eye; snout dorsal

profile convex; lateral ethmoid expanded dorsally and pointed ventrally, vertically oriented ..... ***Apteronotus brasiliensis***

G Whitish transversal band posteriorly on body with dark irregular marks ..... ***Apteronotus caudimaculosus***

GG Whitish transversal band posteriorly on body without dark marks ... ***Apteronotus* aff. *albifrons***

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