

A new *Aspidoras* (Siluriformes: Callichthyidae) from rio Paraguaçu basin, Chapada Diamantina, Bahia, Brazil

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During a recent ichthyological survey in Chapada Diamantina, Estado da Bahia, Brazil, a new, very distinctive *Aspidoras* was discovered in tributaries of the upper rio Paraguaçu. The new taxon differs from its congeners mainly in having: a poorly-developed pigmentation pattern, restricted to minute scattered blotches on dorsal region of head and body, but grouped in small, irregular blotches along the lateral body plate junction; four or five caudal vertebra, anterior to compound caudal centrum, with neural and haemal spines placed posteriorly, close to post-zygapophyses; and post-zygapophyses of the precaudal vertebrae without dorsal expansions connected with their respective neural spines. The new species shares with *Aspidoras velites* dorsolateral body plates not touching their counterparts dorsally, and infraorbital bones with reduced flanges that are restricted to the latero-sensory canal. Both of these are considered reductive character states, probably indicating a paedomorphic condition to both species. The new species is also compared to *Aspidoras maculosus*, a congener which bears the most similar color pattern and is geographically closest to the new species.

Durante um estudo recente sobre a ictiofauna da Chapada Diamantina, foi descoberta uma nova espécie de *Aspidoras*, bastante distinta morfológicamente de suas congêneres, em afluentes do alto rio Paraguaçu, Estado da Bahia, Brasil. O novo táxon difere das demais espécies de *Aspidoras* principalmente pela pigmentação pouco desenvolvida, restrita a minúsculas máculas espalhadas na região dorsal da cabeça e corpo, concentradas em pequenas manchas irregulares ao longo da junção das placas laterais; por apresentar as quatro a cinco últimas vértebras caudais anteriores ao centro caudal composto com os espinhos neurais e hemais situados posteriormente junto às pós-zigapófises; e pós-zigapófises das vértebras pré-caudais sem expansões dorsais unidas ao respectivo espinho neural. Além disso, a nova espécie compartilha com *Aspidoras velites* a condição em que as placas dorso-laterais não contatam suas contrapartes dorsalmente, e os ossos infra-orbitais reduzidos a pouco mais que o canal látero-sensorial, características reductivas, provavelmente indicando um estado de caráter pedomórfico para estas espécies. A nova espécie é ainda comparada a *Aspidoras maculosus*, congêneres mais semelhante no padrão de colorido e também aquela mais próxima geograficamente.

Key words: Systematics, *Aspidoras maculosus*, Sand-dwelling, Paedomorphic characters.

Introduction

The genus *Aspidoras* Ihering includes 19 nominal species of catfishes that are generally found in shallow creeks of several river basins draining mainly the Brazilian Shield (Britto *et al.*, 2002). Although the validity of some characters traditionally used to define *Aspidoras*, such as the size of the frontal fontanel and the presence of a parieto-supraoccipital fontanel had been questioned previously (Nijssen & Isbrücker, 1976; Weitzman & Balph, 1979), the monophyly of the genus

was recently demonstrated through phylogenetic studies (Reis, 1998; Britto, 2003).

The increase in ichthyological samplings in Neotropical rivers in decades recently has brought many new taxa to science (Vári & Malabarba, 1998; Schaefer, 1998; Reis *et al.*, 2003). This assertion fits precisely for *Aspidoras*, which has 30% of its species (including the new one presented herein) discovered in recent fish surveys, and described in the last eight years (Britto, 1998, 2000; Lima & Britto, 2001; Britto *et al.*, 2002).

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The rio Paraguaçu is an eastern Brazilian coastal river basin which has its headwaters mostly on the eastern slope of Chapada Diamantina plateau, a relatively high massif (heights up to 2000 meters above sea level) of the Brazilian Shield. In the last few years, the region of the Chapada Diamantina has yielded several new fish species, including an entire assemblage of Trichomycteridae, the Copionodontinae (de Pinna, 1992; Campanario & de Pinna, 2000) and interesting characids (Lima & Gerhard, 2001; Zanata & Akama, 2004; Malabarba *et al.*, 2004). During a recent, broad fish survey conducted in this area, one of the authors (ACAS) collected a distinctive *Aspidoras* species that possesses several uncommon or unique features among the members of the family. We describe below this new species, and we suggest that some of those features might be related to a specialized lifestyle.

Material and Methods

Morphometric and meristic data were taken following Reis (1997), with the addition of the length of the ossified portion of pectoral spine, which was measured from the articulation between the spine and pectoral girdle to distal tip of spine. Measurements were obtained with calipers to 0.1 mm. Counts of teeth and vertebrae were taken only from cleared-and-stained (cs) specimens, which were prepared according to Taylor & Van Dyke (1985). Vertebral counts include only free centra, with the compound caudal centra (preural 1 + ural 1) counted as a single element. Lateral plate counts include all dorsolateral and ventrolateral plates, except for small, irregular plates on caudal peduncle. In the description, numbers in parentheses following each count represent the number of specimens with that value and counts indicated with an asterisk represent counts from the holotype. Nomenclature of latero-sensory canals follows Schaefer & Aquino (2000), and that of preopercular pores follows Schaefer (1988). Osteological terminology follows Reis (1998), except for the use of parieto-supraoccipital instead of supraoccipital (Arratia & Gayet, 1995), compound pterotic instead of pterotic-supracleithrum (Aquino & Schaefer, 2002), and scapulocoracoid instead of coracoid (Lundberg, 1970), as adopted in Britto & Lima (2003). Homologies of barbels follow Britto & Lima (2003). Institutional abbreviations are: FMNH, Field Museum of Natural History, Chicago; MCP, Museu de Ciência e Tecnologia da Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre; MNRJ, Museu Nacional da Universidade Federal do Rio de Janeiro; and MZUSP, Museu de Zoologia da Universidade de São Paulo, São Paulo.

Comparative material is listed in Lima & Britto (2001) and Britto (2003). In addition, the following material was studied: *Aspidoras maculosus* Nijssen & Isbrücker (measurements taken by P. Willink) FMNH 54808 (3), paratypes; FMNH 54809 (1), paratype; FMNH 54810, holotype; FMNH 78361 (2), paratypes; *Corydoras lacerdai* Hieronimus MNRJ 26017 (17, 4 cs); and *Scleromystax* sp. MCP 28729 (20, 3 cs); MCP 29299 (5, 1 cs).

Aspidoras psammatides, new species

Figs. 1-5

Holotype. MNRJ 28407 (25.7 mm SL) Brazil, Estado da Bahia, município de Lençóis, rio Caldeirão, 12°39'33"S 41°22'12"W; A. C. A. Santos, 6 Nov 1999.

Paratypes. All from Brazil, Estado da Bahia, município de Lençóis: MNRJ 21269 (51, 15.4-27.8 mm SL); MZUSP 67194 (20, 17.1-27.6 mm SL); same data as holotype. MNRJ 21270 (26, 2 cs, 15.9-30.4 mm SL); MZUSP 67195 (20, 16.6-31.0 mm SL); rio Capivara, 12°37'19"S 41°22'35"W; A. C. A. Santos, 13 Mar 1999. MNRJ 21708 (7, 14.4-21.2 mm SL) rio Roncador, 12°42'01"S 41°21'26"W; A. C. A. Santos, 13 Mar 1999. MNRJ 21709 (50, 2 cs, 15.0-28.4 mm SL) rio Caldeirão, 12°39'33"S 41°22'12"W; A. C. A. Santos, 13 Mar 1999. MNRJ 21710 (18, 1 cs, 16.7-24.9 mm SL) rio Roncador, 12°42'01"S 41°21'26"W; A. C. A. Santos, 6 Nov 1999. MNRJ 21711 (47, 16.5-27.9 mm SL) rio Capivara, 12°37'19"S 41°22'35"W; A. C. A. Santos, 6 Nov 1999. MNRJ 21712 (1, 23.2 mm SL) rio Ribeirão, 12°35'10"S 41°22'57"W; A. C. A. Santos, 6 Nov 1999.

Diagnosis. *Aspidoras psammatides* differs from its congeners by the following exclusive features: poorly-developed pigmentation, restricted to minute scattered blotches on dorsal region of head and body, grouped in small, irregular blotches along lateral body plate junction (*vs.* dense pigmentation, in marbled or striped pattern); four or five caudal vertebra (*vs.* only three vertebra) anterior to compound caudal centrum, with neural and haemal spines placed posteriorly, close to post-zygapophyses; minor least interorbital distance (19.9 - 27.8% in HL *vs.* greater than 28% in HL); and post-zygapophyses of precaudal vertebrae not showing dorsal expansions connected with its respective neural spine (*vs.* post-zygapophyses connected with their respective neural spine).

Description. Morphometric data presented in Table 1. Head compressed with slightly convex dorsal profile; roughly triangular in dorsal view (Fig. 2). Snout rounded. Head profile convex from upper lip to vertical through middle of parieto-supraoccipital; body slightly convex from that point to base of last dorsal-fin ray. Postdorsal-fin body profile slightly concave to adipose-fin spine; markedly concave from this point to caudal-fin base. Ventral profile of body slightly convex from isthmus to anal-fin origin; slightly pronounced between pectoral fins. Profile markedly concave from first anal-fin ray to caudal-fin base. Body elongated; roughly cylindrical in cross section at pectoral girdle, gradually becoming more compressed toward caudal fin.

Eye rounded, dorso-laterally on head; orbit delimited dorsally by frontal and sphenotic, ventrally by infraorbitals. Anterior and posterior nares close to each other, only separated by flap of skin. Anterior naris tubular. Posterior naris close to anterodorsal margin of orbit, separated from it by distance equal to naris diameter. Mouth small, subterminal, width nearly equal to bony orbit diameter. Maxillary barbel elongate, but not reaching anteroventral limit of gill opening.



Fig. 1. *Aspidoras psammatides*, holotype, MNRJ 28407, 25.7 mm SL, Brazil, Estado da Bahia, município de Lençóis, rio Caldeirão.

Maxillary barbel slightly longer than outer mental barbel. Inner mental barbel fleshy. Small rounded papillae covering entire surface of all barbels, upper and lower lips, and isthmus. Gill membranes united to isthmus. Four branchiostegal rays covered by thick layer of skin; distal two rays united at their tips by branchiostegal cartilage. Teeth on upper pharyngeal tooth plate 28 (2) or 34 (1), and on fifth ceratobranchial 22 (1) or 24 (2).

Nasal, frontal, sphenotic, compound pterotic, and parieto-supraoccipital visible externally, all covered by thin layer of skin and bearing minute scattered odontodes. Frontal fontanel elongate, ellipsoid, covered by thin layer of skin, and reaching anterior border of parieto-supraoccipital. Parieto-supraoccipital fontanel round, located in the middle of bone. Nasal slender, slightly curved laterally, mesial border contacting frontal and mesethmoid. Frontal roughly rectangular; anterior expansion in contact with nasal bone and mesethmoid, posterior portion contacting sphenotic and parieto-supraoccipital. Sphenotic trapezoid in shape, contact-

ing parieto-supraoccipital dorsally, compound pterotic posteriorly, and second infraorbital ventrally. Compound pterotic roughly pipe-shaped, with slender posterior expansion contacting first dorsal body plate dorsally, and first lateral-line ossicle posteriorly. Ventral margin of compound pterotic contacting opercle and cleithrum. Parieto-supraoccipital quadrangular with posterior expansion triangular and short, not reaching nuchal plate (Fig. 2).

Two narrow infraorbital bones nearly restricted to laterosensory canal, externally visible, covered by thin layer of skin. Both bearing few minute odontodes. First infraorbital with very short anterior expansion (flange; Fig. 3). Minute odontodes-bearing platelets dorsally on orbit. Opercle exposed, ovoid in shape and roughly elongate, with angular free border. Preopercle externally visible, slender and covered by thin layer of skin. Interopercle triangular, covered by thin layer of skin.

Table 1. Morphometric data of holotype and paratypes of *Aspidoras psammatides*.

	Holotype	Paratypes (n = 51)		
		mean	range	
Standard length (mm)	25.7	25.3	20.4	31.0
Percents of Standard length				
Depth of body	21.5	19.8	16.9	23.5
Predorsal distance	45.6	44.6	41.4	47.6
Prepelvic distance	46.0	44.7	41.7	48.6
Preanal distance	77.7	76.2	70.7	82.6
Preadipose distance	78.3	78.3	71.0	82.0
Length of dorsal spine	13.2	12.7	10.5	15.0
Length of pectoral spine	14.3	13.4	10.5	17.5
Length of adipose-fin spine	9.4	10.6	6.9	13.5
Depth of caudal peduncle	8.7	9.0	7.5	10.1
Dorsal to adipose distance	21.7	23.2	14.8	28.8
Length of dorsal-fin base	16.0	16.0	12.7	21.9
Maximum cleithral width	9.1	11.6	8.7	22.3
Head length	35.4	37.0	34.7	40.5
Length of maxillary barbel	13.8	13.8	10.6	20.0
Percents of Head length				
Head depth	60.0	57.3	34.2	63.2
Least interorbital distance	22.4	22.5	19.9	27.8
Horizontal orbit diameter	21.1	21.9	18.8	24.6
Snout length	47.0	47.2	40.0	54.4
Least internareal distance	17.8	18.4	10.9	24.9

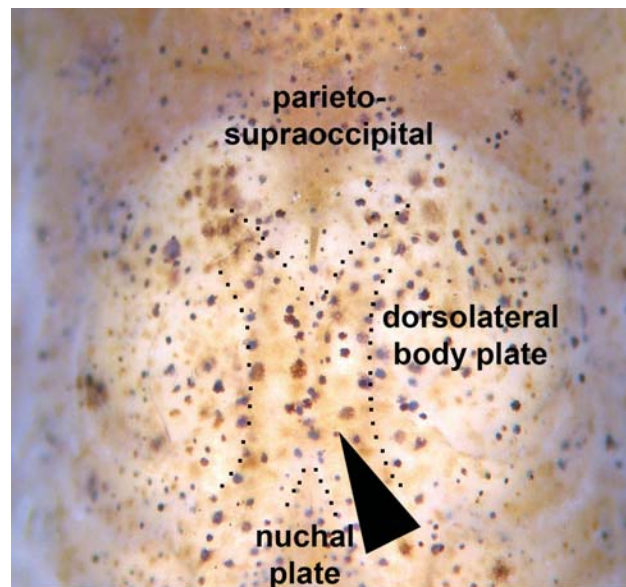


Fig. 2. Dorsal view of head of *Aspidoras psammatides*, holotype, MNRJ 28407, 25.7 mm SL. Arrow: naked groove between parieto-supraoccipital posterior process and nuchal plate.

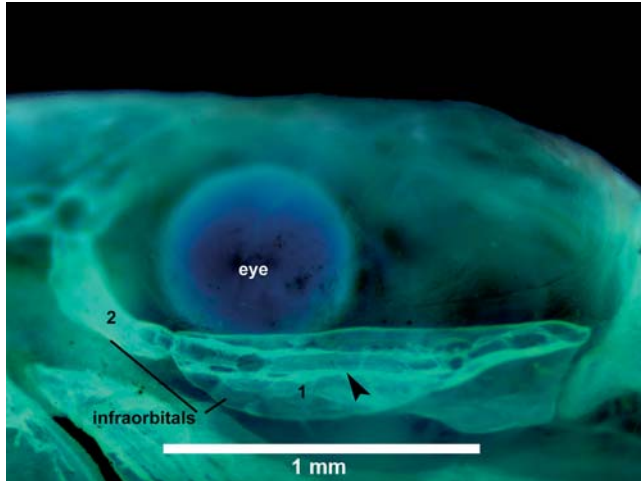


Fig. 3. Orbital region of *Aspidoras psammaticides*, paratype, MNRJ 21709, 22.6 mm SL, right side. Arrow: latero-sensory canal.

Trunk lateral-line composed of one perforated dorsolateral-body plate and two laterosensory canals, reduced to small osicles. Lateral-line canal entering neurocranium through compound pterotic, splitting posterior of sphenotic into pterotic and preoperculomandibular branches, each with single pore. Sensory canal continuing through compound pterotic, entering sphenotic as temporal canal, which splits into two branches: one branch giving rise to infraorbital canal, other branch entering frontal through supraorbital canal. Supraorbital canal with two branches: epiphyseal branch opening in frontal bone, and anterior branch running through nasal bone. Nasal canal with single opening at each end. Infraorbital canal running through entire second infraorbital, extending to infraorbital 1 and opening into two pores. Preoperculomandibular branch not connected to preoperculomandibular canal, which runs through entire preopercle with three openings, leading to pores 3, 4, and 5, respectively.

Body plates with minute odontodes restricted to posterior margins. Nuchal plate exposed. Cleithrum exposed. Dorsolateral body plates between parieto-supraoccipital process and nuchal plate not touching counterparts, leaving narrow naked area; specimens less than 26.4 mm SL also shows naked area between last dorsal-fin ray and first preadipose platelet. Dorsolateral body plates 26 (2), 27* (24), 28 (24), or 29 (2); ventrolateral body plates 24 (19), 25* (25), or 26 (8); dorsolateral body plates along dorsal-fin base 6 (12) or 7* (40); dorsolateral body plates from adipose fin to caudal-fin base 8 (2), 9 (8), 10* (23), 11 (18), or 12 (1); preadipose platelets 2 (1), 3 (11), 4* (35), 5 (4), or 6 (1). Precaudal vertebrae 7 (2) or 8 (3); caudal vertebrae 18 (5). Four to five caudal vertebra, anterior to compound caudal centrum, with neural and haemal spines placed posteriorly, close to post-zygapophyses (Fig. 4). Post-zygapophyses of precaudal vertebrae reduced, not showing dorsal expansions connected with respective neural spine (Fig. 5). Five (4) or seven (1) pairs of ribs, first pair conspicuously larger than others.

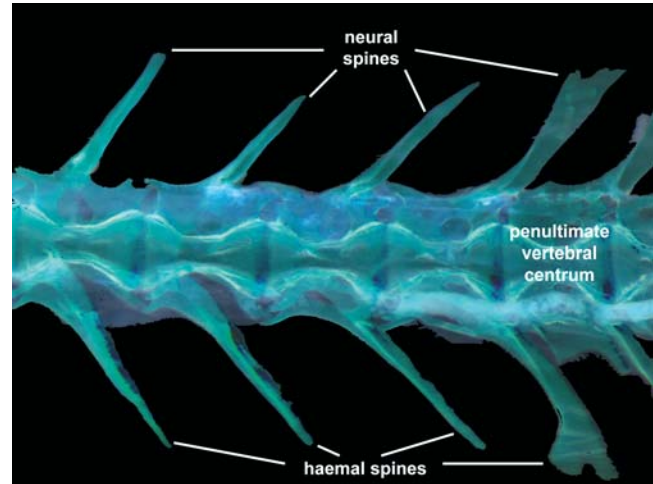


Fig. 4. Detail of the region anterior to the compound caudal centrum of *Aspidoras psammaticides*, paratype, MNRJ 21709, 22.6 mm SL, showing neural and haemal spines close to its respective post-zygapophyses.

Dorsal fin roughly triangular; its origin just posterior to third dorsolateral body plate. Dorsal spine shorter than first five branched rays. Distal tip of spine with minute-segmented unossified portion. Anterior and posterior border of dorsal spine smooth. Dorsal-fin rays I,8 in all specimens examined. Adipose fin roughly triangular; its origin separated from base of last dorsal-fin ray by seven to eight dorsolateral body plates. Anal fin roughly ovoid; its origin located just posterior to 13th to 16th ventrolateral body plates, at vertical through anterior margin of adipose-fin spine. Anal-fin rays ii,5,i*; one specimen (MNRJ 21710, 24.6 mm SL) ii,4,i. Pectoral fin roughly rounded; its origin located just posterior to gill opening. Ossified portion of pectoral spine shorter than first five branched rays. Distal tip of spine with minute-segmented unossified portion. Pectoral spine with well-developed serrations along entire posterior border. Pectoral-fin rays I,9* (27) or I,10 (25). Pelvic fin ellipsoid; its origin just below second ventrolateral body plate, at vertical through base of third branched dorsal-fin ray. Pelvic-fin rays i, 5. Caudal fin bilobed; both lobes equal in size. Principal caudal-fin rays i,6/6,i*, one specimen (MNRJ 21711, 27.4 mm SL) i,6/5,i; upper procurrent caudal-fin rays iv; lower procurrent caudal-fin rays iv. All fins with minute odontodes scattered over all rays.

Color in alcohol. Ground coloration of head light brown to yellowish white. Several chromatophores clustered in minute brown dots scattered over dorsal and lateral surface of head. Dots more concentrated on posterodorsal portion of opercle and on side of snout forming discrete stripe from anteroventral region of orbit to snout tip. Larger individuals (up to 26.4 mm SL) with dots grouped in small blotches. Small specimens with scattered minute brown blotches on anterior portion of snout. All barbels yellowish white; few chromatophores present on barbels in some individuals.

Ground color of trunk light brown to yellowish white. Dif-

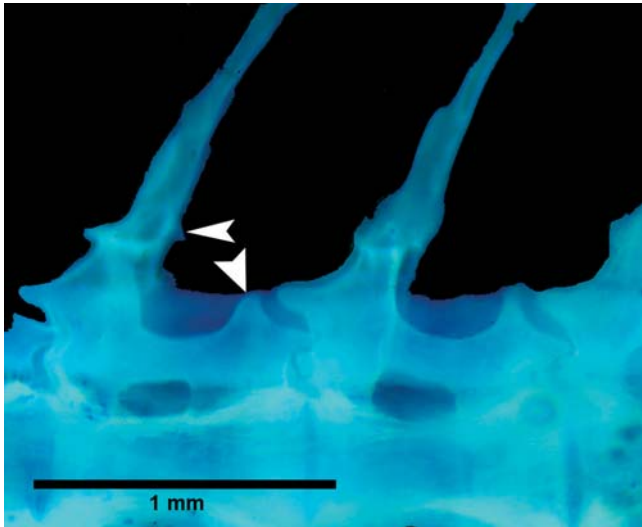


Fig. 5. Detail of the dorsal region of precaudal vertebrae of *Aspidoras psammatides*, paratype, MNRJ 21709, 22.6 mm SL, showing their post-zygapophyses not connected with respective neural spine (arrows).

fuse brown blotch on middle region of cleithrum. Minute dark brown dots scattered over entire surface of trunk; more concentrated on dorsal region. Dots clustered around bases of dorsal spine, last dorsal-fin ray and adipose-fin spine, respectively. Small diffuse brown blotches along lateral junction of body plates, from cleithrum to caudal peduncle. Blotches varying in number from five to (more commonly) eight blotches. Ventral surfaces of body yellowish white.

Interradial membrane of all fins hyaline. Dorsal fin with few chromatophores scattered on dorsal spine and first two to three adjacent rays, scarcely present on their tips. Ground color of anal-fin rays yellowish white. Some individuals with sparse chromatophores on base of rays. Few chromatophores scattered over adipose-fin spine; some individuals with chromatophores also on adipose-fin membrane adjacent to spine and on its apex. All pectoral-fin rays and spine yellowish white. Larger specimens with sparse chromatophores on first two branched rays. Pelvic-fin rays hyaline. Caudal-fin rays yellowish white with several chromatophores clustered in three-four patches restricted to the three outermost rays of both lobes. Color in life very similar to that of preserved specimens.

Sexual dimorphism. As usual for corydoradines (e.g. Nijssen & Isbrücker, 1980: 130; Britto, 2003: 142, fig. 23), males of *Aspidoras psammatides* possess a lanceolated papilla. However, relatively few males show a well-developed papilla, which made the determination of sex in most specimens more difficult than with other *Aspidoras* species (e.g. Britto, 1998, 2000, Lima & Britto, 2001, Britto *et al.*, 2002).

Habitat and ecological notes. The species is known from affluents of the rio São José, one of the main tributaries of the upper course of rio Paraguaçu, which has several relatively small tributaries entering its right margin. The species was

collected in four of these tributaries, rio Roncador, rio Capivara, rio Ribeirão and rio Caldeirão. The rio São José and its tributaries are all blackwater rivers. The type locality of *Aspidoras psammatides*, rio Caldeirão, has sandy and rocky bottom, with little amount of riparian and submerged vegetation.

Distribution. *Aspidoras psammatides* is known only from tributaries of the upper rio Paraguaçu, a coastal river basin from eastern Brazil (Fig. 6)

Etymology. *Psammatides*, after “Psammatos psammatides”, “the sand sorcerer”, a character of J.R.R. Tolkien’s book “Roverandom”, from the Greek *psammos*, sand, and *ides*, son of. In allusion to the sand-dwelling behavior of the species. A noun in apposition.

Discussion

Aspidoras psammatides is remarkable among its congeners by displaying a suite of characters apparently related to paedomorphosis. Some of them are shared with *Aspidoras velites*, such as dorsolateral body plates not touching their counterparts dorsally and infraorbital bones with reduced flanges, nearly restricted to the laterosensory canal. Despite possessing the predorsal area naked as in *A. velites*, the condition found in *A. psammatides* is not as extreme as that found in the latter species, where not only the anterior dorsolateral plates but also the parieto-supraoccipital process and the

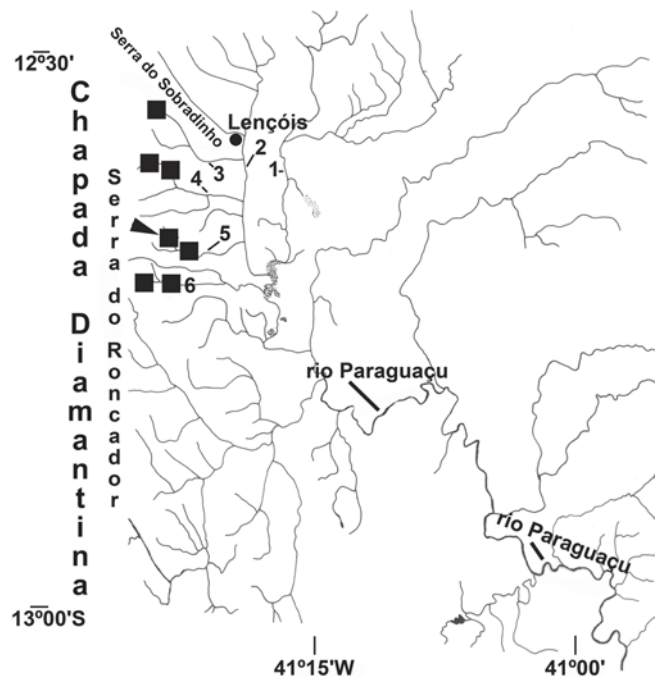


Fig. 6. Map of upper course of rio Paraguaçu showing the distribution of *Aspidoras psammatides* (squares). 1: rio Santo Antônio; 2: rio São José; 3: rio Ribeirão; 4: rio Capivara; 5: rio Caldeirão; 6: rio Roncador; arrow: type locality.

nuchal plate are reduced (Britto *et al.*, 2002). Specimens up to 26.4 mm SL of *A. psammatides* possess dorsolateral body plates not touching their counterparts at the preadipose area, a condition shared with *A. velites* of all sizes. As discussed in Britto *et al.* (2002: 733, 735) and Britto (2003: 128-129), infra-orbital bones with reduced flanges are unusual in corydoradines and only known previously in *Corydoras pygmaeus*, *C. hastatus*, *C. panda*, and *Aspidoras velites*.

Another exclusive character that is apparently paedomorphic for *Aspidoras psammatides* is the post-zygapophyses of precaudal vertebrae not showing dorsal expansions connected with their respective neural spines. This condition is observed, among the remaining callichthyids, only in juvenile specimens. During the ontogeny the post-zygapophyses develop a laminar outgrowth that fuses to the respective neural spine. An additional, although not reductive, autapomorphy for the species is the presence of four or five caudal vertebra, anterior to compound caudal centrum, with neural and haemal spines placed posteriorly, close to post-zygapophyses, whereas in the remaining callichthyids invariably only the three latter vertebrae show the neural spines placed posteriorly.

Among *Aspidoras* species, *A. psammatides* shares a narrow interorbital distance and poorly-developed color pattern with *A. maculosus*, a species described from the headwaters of the rio Itapicuru, an eastern coastal drainage immediately north to the rio Paraguaçu basin in Bahia, Brazil. *Aspidoras maculosus* is only known from its poorly preserved and faded type series, which were not examined in the present study. However, examination of Ellis' (1913: pl. XXVI, fig. 3) illustration, which depicts the pigmentation of the (then) recently collected *A. maculosus* holotype, plus recent pictures of the same specimen, allows a comparison between both species. *Aspidoras psammatides* is clearly distinct from *A. maculosus* in at least two characters, *viz.*, the color pattern, which consists, respectively, in minute scattered blotches on dorsal region of head and body, but grouped in small, irregular blotches along lateral body plate junction (*vs.* three longitudinal series of small rounded blotches, the more conspicuous one along lateral body plate junction), and dorsolateral body plates not touching their counterparts dorsally, leaving a small predorsal naked area (*vs.* dorsolateral body plates touching their counterparts dorsally, leaving no naked predorsal area). In addition, *Aspidoras maculosus* shows an interorbital distance (28.6 - 33.1% HL) somewhat larger than in *A. psammatides* (19.9 - 27.8% HL).

The low degree of development of the pigmentation found in *Aspidoras psammatides* is unique among *Aspidoras* species and recalls the color pattern observed in several unrelated catfish groups such as some African Amphiliidae (*e.g.* *Leptoglanis* spp., *Psamphyletria*, *Dolicamphilius*, *Tetracamphilius*, and *Zaireichthys*; Skelton, 1993: 219-220; Roberts, 2003), South American Trichomycteridae (*e.g.* *Microcambeva* spp.; Costa & Bockmann, 1994; Costa *et al.*, 2004), and also some Asiatic Cypriniformes (*e.g.*, *Acanthopsoides*, Cobitidae; Siebert, 1991) and North American Perciformes ("sand darters", *Ammocrypta* spp.; Page &

Burr, 1991: 288). Apparently these fishes share a lifestyle that involves dwelling in riverine sand bars, where they spend part of their time partially burrowed in the sand. At this time, we know little about *Aspidoras psammatides* habits other than it lives at sandy stretches of rivers, but the combination of its color pattern, elongate body and relatively high-positioned eyes suggest that it might have a similar mode of life as the afore-mentioned fishes.

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