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Ammoglanis multidentatus, a new miniature sand-dwelling sarcoglanidine catfish with unique osteological features from northeastern Brazil (Siluriformes: Trichomycteridae)

Wilson J. E. M. Costa[1,*], José L. O. Mattos[1] & Alexandre C. A. Santos[2]

[1] Laboratory of Systematics and Evolution of Teleost Fishes, Institute of Biology, Federal University of Rio de Janeiro, Caixa Postal 68049, CEP 21941-971, Rio de Janeiro, Brazil – * Corresponding author: wcosta@acd.ufrj.br — [2] Departamento de Ciências Biológicas, Universidade Estadual de Feira de Santana, Km 03, BR-116, CEP 44031-460, Feira de Santana, BA, Brazil

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Abstract

Among the most interesting and poorly known groups of the South American fish fauna is the catfish trichomycterid subfamily Sarcoglanidinae that includes miniature psammophilic species. We herein describe a new species, *Ammoglanis multidentatus* sp. nov., with larger specimens reaching less than 20 mm of standard length. In contrast to other sarcoglanidines that are found in rivers draining rain-forests, this new species was collected in the Rio Paraguaçu basin, Brazilian semiarid Caatinga. *Ammoglanis multidentatus* differs from all other sarcoglanidines by some osteological features, comprising the presence of a ventral process on the sesamoid supraorbital in contact with the latero-posterior process of the autopalatine, a robust opercle with numerous odontodes, and a long anteroventral process of the opercle. The description of *A. multidentatus* expands the geographical range of *Ammoglanis* about 1000 km to east, which highly suggests that unknown species of *Ammoglanis* may occur in several other areas of South America, probably as a result of the absence of fish collections directed to sand habitats.

Key words

Biodiversity; Caatinga; Psammophily; Rio Paraguaçu basin; systematics.

Introduction

Our knowledge about species diversity of freshwater fishes of the Neotropical region has significantly increased in the last decades, when some aquatic habitats rarely or not formerly inventoried by ichthyologists have been frequently sampled (e.g., Costa, 2016). Among the several freshwater fish groups revealed during these inventories are numerous specialized and uncommon catfish taxa, including species inhabiting the bottom zone of deep river channels (Lundberg & Py-Daniel, 1994; Lujan & Chamon, 2008), glanapterygine trichomycterids only found buried in shallow leaf-litter deposits (Landim & Costa, 2002), and members of different trichomycterid lineages with specialised psammophilic habits (Costa *et al.*, 2004; Schaeffer *et al.*, 2005).

Among the psammophilic trichomycterids are the sarcoglanidines, which often reach a very small maximum adult size, usually between about 15 and 25 mm of standard length (SL) (de Pinna, 1989a; Costa & Bockmann, 1994; de Pinna & Winemiller, 2000; Mattos *et al.*, 2008). Available field data indicate that sarcoglanidines inhabit patches of loose sand substrate, both in clearwater streams (Costa, 1994; Costa & Bockmann, 1994; Zuanon & Sazima, 2004) and in tea-stained blackwater streams (de Pinna & Winemiller, 2000). When

disturbed, sarcoglanidines bury in the sand (Zuanon & Sazima, 2004); field observations indicate that *Microcambeva ribeirae* Costa, Lima & Bizerril, 2004 often stays buried in the sand substrate keeping only the top of the head and barbels visible above the river bottom (Costa et al., 2004), and *Ammoglanis pulex* de Pinna & Winemiller, 2000 may have fossorial habits, being found at least 20 cm deep into the sandy substrate (de Pinna & Winemiller, 2000).

Sarcoglanidines were recognised as a separate subfamily of the Trichomycteridae, the Sarcoglanidinae, by Myers & Weitzman (1966), with the description of two Amazonian taxa, *Sarcoglanis simplex* Myers & Weitzman, 1966 and *Malacoglanis gelatinosus* Myers & Weitzman, 1966. Sarcoglanidines are today represented by eight species in five genera, *Ammoglanis* Costa, 1994, *Malacoglanis* Myers & Weitzman, 1966, *Sarcoglanis* Myers & Weitzman, 1966, *Stauroglanis* de Pinna, 1989, and *Stenolicmus* de Pinna & Starnes, 1990, occurring in the Amazonas and Orinoco river basins (Myers & Weitzman, 1966; de Pinna, 1989a; de Pinna & Starnes, 1990; Costa, 1994; de Pinna & Winemiller, 2000; Mattos *et al.*, 2008; Wosiacki *et al.*, 2011), and three species belonging to a single genus, *Microcambeva* Costa & Bockmann, 1994, endemic to the Atlantic Forest of eastern Brazil (Costa & Bockmann, 1994; Costa *et al*., 2004; Mattos & Lima, 2010). We herein describe a new species of *Ammoglanis* exhibiting unique osteological features. In contrast to its congeners that occur in the Amazonas and Orinoco river basins, Amazon Forest, the new species was collected in the Rio Paraguaçu basin, Brazilian semiarid Caatinga.

Materials and methods

Specimens were collected using electrofishing according to the CEN 14011 standard protocol (CEN, 2003), and euthanized just after collection using menthol solution. Material examined is deposited in the following institutions: MNRJ, Museu Nacional, Rio de Janeiro; UEFS, Universidade Estadual de Feira de Santana, Feira de Santana; UFRJ, Instituto de Biologia, Universidade Federal do Rio de Janeiro, Rio de Janeiro. Three of the eight specimens of the type series were cleared and stained for bone and cartilage (C&S) following Taylor & Van Dyke (1985); osteological characters appearing in the description are those belonging to structures of the mesethmoidal region, suspensorium and opercular apparatus, which have informative variability among sarcoglanidines and are consequently often used in their original descriptions. Osteological nomenclature follows Datovo & Bockmann (2010). Osteological illustrations were made using a stereomicroscope Zeiss Stemi SV 6 with camera lucida. Morphometric and meristic data were taken following Costa (1992); measurements are presented as percent of standard length (SL), except for those related to head morphology, which are expressed as percent of head length. Fin-ray counts include all elements; vertebra counts include all vertebrae except those participating in the Weberian apparatus; the compound caudal centrum was counted as a single element.

Author contributions

WJEMC conceived and designed the study, secured funding for the study, analyzed data, prepared illustrations, wrote the manuscript; JLOM prepared material, prepared photographs, analysed data; ACAS collected material, secured funding for field collection, generated data on field notes, reviewed the manuscript drafts.

Results

Ammoglanis multidentatus sp. nov.

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(Figs 1–2; Table 1)

Holotype. MNRJ 51340, 17.6 mm SL; Brazil: Estado da Bahia: Município de Lençóis: Rio Caldeirão, Rio Paraguaçu basin, 12°39′33″S, 41°22′13″W, altitude about 340 m above sea level; A.C.A. Santos *et al*., 21 September 2012.

Paratypes. MNRJ 51341, 1 ex., 16.6 mm SL; UEFS 15195, 2 ex., 17.3–18.7 mm SL; UFRJ 12088, 1 ex., 19.7 mm SL; UFRJ 12089, 3 ex. (C&S), 16.9–19.3 mm SL; all collected with the holotype.

Diagnosis. *Ammoglanis multidentatus* is distinguished from all other sarcoglanidines by the presence of a ventral process on the sesamoid supraorbital, in contact with the latero-posterior process of the autopalatine (Fig. 2A; vs. process absent), a prominent dorso-lateral process on the premaxilla (Fig. 2A; vs. process absent), more opercular odontodes (opercular odontodes 15–16, vs. 7–11), and a long anteroventral process of the opercle, its length about equal the length of the opercle main axis excluding the odontode patch (Fig. 2B; vs. about one third to half length, Costa, 1994: Fig. 5, de Pinna & Winemiller, 2000: Fig. 5, Mattos et al., 2008: Fig. 2). It is also distinguished from all congeners in having a long sesamoid supraorbital, its length about thrice the antorbital length (Fig. 2A; vs. sesamoid supraorbital only slightly longer than the antorbital in *A. amapaensis* and *A. diaphanus*, Costa, 1994: Fig. 3, Mattos *et al.*, 2008: Fig. 5, and sesamoid supraorbital rudimentary in *A. pulex*, de Pinna & Winemiller, 2000: Fig. 6), a robust opercle, its depth excluding dorsal and anteroventral processes slightly larger than the width of the dorsal extremity of the hyomandibula (Fig. 2B; vs. narrower, Costa, 1994: Fig. 5, de Pinna & Winemiller, 2000: Fig. 5; Mattos *et al.*, 2008: Fig. 2), and more pelvic-fin rays (total of 6, vs. 4 or 5). *Ammoglanis multidentatus* also differs from *A. amapaensis* and *A. pulex* by having a well-developed postero-lateral

Fig. 1. *Ammoglanis multidentatus* sp. nov., MNRJ 51340, holotype, 17.6 mm SL: **A**, left lateral view; **B**, head, dorsal view; **C**, head, ventral view.

process of the autopalatine (Fig. 2B; vs. rudimentary, de Pinna & Winemiller, 2000: Fig. 6; Mattos *et al.*, 2008: Fig. 5); and the autopalatine with a constriction on its middle portion, making the lateral and medial margins strongly concave (Fig. 2A; vs. without constriction, lateral margin nearly straight, de Pinna & Winemiller, 2000: Fig. 6; Mattos *et al.*, 2008: Fig. 5); from *A. pulex* by the presence of a metapterygoid.)(vs. absence of a middle constriction, lateral margin slightly concave, medial margin slightly convex, de Pinna & Winemiller, 2000: Fig. 6; Mattos *et al.*, 2008: Fig. 5); from *A. pulex* by the presence of teeth on the dentary (vs. absence) and absence of finger-like projections on the chin region (vs. presence, de Pinna & Winemiller, 2000: Fig. 2B); from *A. amapaensis* by the presence of a cranial fontanel (vs. dorsal surface of the neurocranium totally ossified, without a fontanel, Mattos *et al.*, 2008: Fig. 4), absence of a small ossification on the anterior portion of the autopalatine (vs. presence, Mattos *et al.*, 2008: Fig. 5); from *A. diaphanus* in possessing a longer nasal barbel, its tip reaching the anterior margin of the orbit (vs. its tip reaching an area anterior to posterior naris), the origin of the anal fin posterior to the dorsal-fin base (vs. in a vertical through the posterior portion of the dorsal-fin base), the maxilla slightly longer than premaxilla (Fig. 2A, vs. about twice longer, Costa, 1994: Fig 3), more procurrent caudal-fin rays (dorsal viii–x , vs. v–vi; ventral ix–x, vs. vii); more interopercular odontodes (10–11 vs. 7), fewer vertebrae (31 vs. 33), and absence of an anterior projection on the interopercle (vs. presence, Costa, 1994: Fig. 5).

Description. Morphometric data appear in Table 1. Body slender, subcylindrical and slightly depressed anteriorly, compressed posteriorly. Greatest body depth at vertical just in front pelvic-fin base. Dorsal and ventral profiles of head and trunk slightly convex, approximately straight on caudal peduncle. Anus and urogenital papilla in vertical through middle of dorsal-fin base. Head narrow, subtriangular in lateral view. Anterior profile of snout convex in dorsal view. Eye elliptical, dorsally positioned in head. Posterior naris equidistant from anterior naris and anterior margin of orbit. Tip of maxillary barbel reaching dorsal margin of opercle; tip of rictal barbel reaching anterior part of interopercle; tip of nasal barbel reaching anterior margin of orbit. Mouth subterminal. Chin region without finger-like projections. Teeth conical, 10–11 on premaxilla, irregularly arranged; 11–13 on dentary, arranged in two irregular rows. Branchial membrane attached to isthmus only at its anterior point. Opercular od-

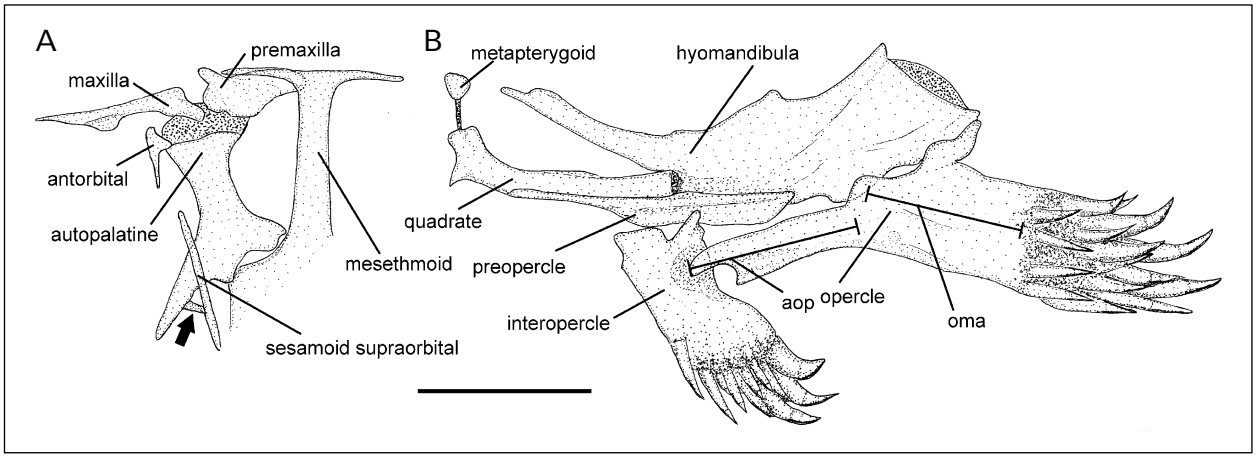

Fig. 2. Osteological structures of *Ammoglanis multidentatus* sp. nov., UFRJ 12089, paratype, 18.6 mm SL: **A,** mesethmoidal region and adjacent structures, left and middle portions, dorsal view; **B,** left suspensorium and opercular series, lateral view. Arrow indicates the ventral process on the sesamoid supraorbital. Larger stippling represents cartilaginous areas. aop, anteroventral opercular process length; oma, opercle main axis length. Scale bar: 1 mm.

Table 1. Morphometric data of *Ammoglanis multidentatus* sp. nov.

	holotype	**range** (n=7)
Standard lenght (mm)	17.6	16.6–19.7
Percentages of standard length		
Body depth	13.0	11.7–13.9
Depth of caudal peduncle	8.7	8.2–9.6
Body with	15.8	13.1–15.4
Width of caudal peduncle	2.1	2.0–2.9
Length of dorsal-fin base	12.5	9.8–13.0
Length of anal-fin base	8.2	7.0–8.2
Length of pelvic fin	12.3	12.0–16.3
Length of pectoral fin	18.5	18.3–20.8
Predorsal length	58.6	56.7–59.4
Prepelvic length	52.8	51.1–54.3
Head length	22.2	20.4–22.5
Percentages of head length		
Head depth	43.2	42.1–47.6
Head width	81.3	77.6–91.4
Interorbital width	21.2	18.9–23.6
Preorbital length	36.3	33.5–37.9
Eye diameter	16.1	14.9–18.3

ontodes 15–16, interopercular odontodes 10–11. Dorsal surface of neurocranium with broad lozenge-shaped fontanel between frontals and anterior portion of sesamoid supraorbital.

Dorsal fin subtriangular; dorsal-fin rays ii+6+i. Anal fin subtriangular, its origin in vertical posterior to dorsal-fin base; anal-fin rays ii+4+i, plus two rudimentary rays on fin origin. Caudal fin subtruncate, ventral portion slightly longer than dorsal portion; principal caudal-fin rays i+10+ii, caudal procurrent rays viii–x+ix–x. Lower hypural plate, corresponding to hypurals 1–2, undivided; upper hypurals, corresponding to hypurals 3–5, composing two plates completely or partially separated by gap. Pelvic fin slightly pointed, its tip reaching vertical through middle of dorsal-fin base, pelvic-fin bases medially separated by interspace nearly equal to pelvic-fin base width; pelvic-fin rays i+5. Pectoral fin subtriangular in dorsal view, first pectoral-fin ray terminating in long filament reaching about 50 % of pectoral-fin length without filament; pectoral-fin rays i+6–7. Dorsal-fin origin on vertical through vertebra 13, anal-fin origin on vertical through vertebra 19, pelvic-fin insertion on vertical through vertebra 11. Vertebrae 31; ribs 3.

Mesethmoidal region and adjacent structures (Fig. 2A). Anterior margin of mesethmoid nearly straight, mesethmoid cornua not widely distally. Antorbital comma-shaped in dorsal view; sesamoid supraorbital rod-like, about so wide as mesethmoid cornua, long, about thrice antorbital length, with ventral process in contact with latero-posterior process of autopalatine. Premaxilla sub-rectangular in dorsal view, with lateral process. Maxilla slender, slightly longer than premaxilla. Autopalatine with constriction on middle portion, making lateral and medial margins strongly concave; latero-posterior process of autopalatine slender and long, about half autopalatine length without latero-posterior process; cartilaginous head of autopalatine long, about one third of autopalatine without latero-posterior process; anterior autopalatine ossification absent.

Suspensorium and opercular apparatus (Fig. 2B). Metapterygoid minute, subtriangular, its greatest length about equal to length of antero-dorsal portion of quadrate. Quadrate long and slender, its length about 75% length of hyomandibula without anterior process, its depth about 15% to quadrate total length; postero-dorsal process of quadrate absent. Hyomandibula with narrow, pointed anteriorly directed process, its length about 60% hyomandibula longitudinal length excluding process, its tip anteriorly reaching vertical through anterior fourth of quadrate. Interopercle compact, without anterior projection. Opercle robust, its greatest depth slightly shorter

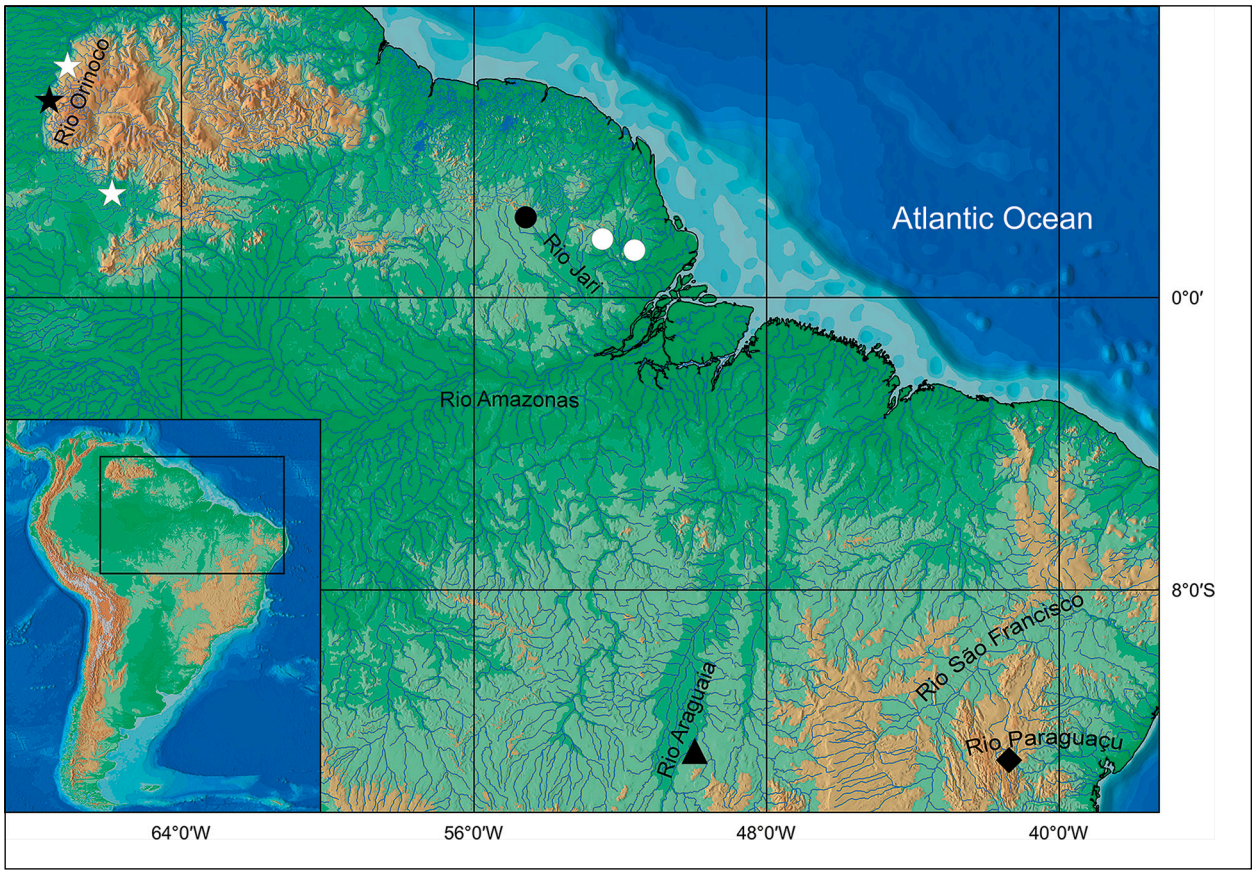

Fig. 3. Map of geographical distribution of *Ammoglanis*: diamond, *A. multidentatus*; triangle, *A. diaphanus*; dots, *A. amapaensis*; stars, *A. pulex*. Black symbols indicate type localities.

than its longitudinal length, excluding processes and odontodes patch; anteroventral process of opercle long, its length about equal length of opercle main axis excluding odontode patch.

Colouration in alcohol. General colouration of trunk and head pale yellow, with few minute dark chromatophores on dorsum, flank and head side. Fins hyaline.

Etymology. From the Latin *multidentatus*, meaning "with many teeth", an allusion to the numerous opercular odontodes (15–16), unique among sarcoglanidines.

Distribution and habitat. *Ammoglanis multidentatus* is known from a single locality, the Rio Caldeirão, a tributary of the Rio São José, which is among the main tributaries of the upper Rio Paraguaçu River (Fig. 3). The Rio São José and its tributaries are black-water rivers. At the type of locality of *A. multidentatus*, the bottom consisted of sand and rocks, with scarce submerged riparian vegetation. Another psammophilic species found in this locality was the callichthyid catfish *Aspidoras psammatides* Britto, Lima & Santos, 2005, endemic to this area (Britto *et al.*, 2005). The cichlid *Geophagus diamantinensis* Mattos, Costa & Santos, 2015 is also found in the Rio Caldeirão (Mattos *et al.*, 2015) and is possibly associated to river sandy stretches.

Discussion

Unique morphological features

Ammoglanis multidentatus exhibits three osteological features unique among congeners, comprising the presence of a ventral process on the sesamoid supraorbital, in contact with the latero-posterior process of the autopalatine (Fig. 2A), a prominent dorso-lateral process on the premaxilla (Fig. 2A), a robust opercle with numerous odontodes (Fig. 2B), and a long anteroventral process of the opercle, its length about equal the length of the opercle main axis excluding processes and the odontode patch (Fig. 2B). The first three conditions are not present in any other sarcoglanidines (e.g., de Pinna, 1989a; de Pinna & Starnes, 1990), and not even in the Glanapteryginae (e.g., de Pinna, 1989b; de Pinna & Kirovsky, 2011; de Pinna & Zuanon, 2013), the putative sister group of the Sarcoglanidinae (Costa & Bockmann, 1994), therefore considered as unambiguous autapomorphies of *A. multidentatus*. Among sarcoglanidines and glanapterygines, a long anteroventral process of the opercle like that exhibited by *A. multidentatus* is only present in *Typhlobelus auriculatus* de Pinna & Zuanon, 2013 (see de Pinna & Zuanon, 2013: Fig. 4A), herein interpreted as a derived condition, independently acquired in the two distantly related taxa.

Relationships

In spite of the unique osteological character states above described, *A. multidentatus* is clearly a member of the genus *Ammoglanis* by having a long and slender quadrate, its greatest length about 75 % of the length of the hyomandibula without anterior process and its greatest depth about 15 % to the quadrate total length (Fig. 2 B), which has been used to diagnose the genus (Costa, 1994) and was confirmed to occur in all other congeners (de Pinna & Winemiller, 2000; Mattos *et al.*, 2008). *Ammoglanis multidentatus* is also distinguished from all other species of *Ammoglanis* by having a long sesamoid supraorbital, about thrice antorbital length (Fig 2A), more pectoral-fin rays (8 vs. 5–7) and more pelvic-fin rays (6 vs. 4 or 5), but these conditions are variable in other sarcoglanidine genera, making difficult to objectively establish character state polarization.

The general morphology of the autopalatine is similar in *Ammoglanis multidentatus* and *A. diaphanus*, including lateral and medial margins strongly concave and the presence of a long postero-lateral process (Fig. 2A, Costa, 1994: Fig. 3), highly differing from the compact autopalatine with the lateral margin only slightly concave and the medial margin slightly convex, bearing a rudimentary postero-lateral process (de Pinna & Winemiller, 2000: Fig. 6; Mattos *et al.*, 2008: Fig. 5). However, the autopalatine morphology recorded for *A. diaphanus* and *A. multidentatus* is also found in other sarcoglanidines non-*Ammoglanis*, including species of *Microcambeva* (Costa & Bockmann, 1994). Therefore, we infer that the autopalatine morphology occurring in *A. diaphanus* and *A. multidentatus* is a plesiomorphic condition among sarcoglanidines, and that unique morphology illustrated by de Pinna & Winemiller (2000: Fig. 6) and Mattos *et al.* (2008: Fig. 5) for *A. pulex* and *A. amapaensis*, respectively, is apomorphic, and thus considered as evidence of closely relationships among these last two species.

Sarcoglanidine geographical distribution

The description of *A. multidentatus* expands the geographical range of *Ammoglanis* in about 1000 km to east (Fig. 3), besides providing the first record of a sarcoglanidine to a river draining a semiarid region, the Caatinga of northeastern Brazil. Other sarcoglanidine species have been recorded only for rain-forest areas (e.g., Myers & Weitzman, 1966; de Pinna, 1989a; Costa, 1994; Mattos *et al.*, 2008). This new record highly suggests that unknown species of *Ammoglanis* may occur in several other areas of South America, between their east-west distribution extremes, i.e. between the Orinoco and Paraguaçu river basins, measuring a distance about 3500 km (Fig. 3). For example, the Rio São Francisco basin, the third largest South American river basin, crosses a region between the type localities of *A. diaphanus* and *A. multidentatus*. However, no sarcoglanidine is known to occur in the Rio São Francisco basin, probably as a result of the absence of fish collections directed to sandy habitats.

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References

Britto, M. R., Lima, F. C. T. & Santos, A. C. A. (2005). A new *Aspidoras* (Siluriformes: Callichthyidae) from rio Paraguaçu basin, Chapada Diamantina, Bahia, Brazil. *Neotropical Ichthyology*, **3**, 473–479.

CEN (2003). prEN 14011 Water quality – Sampling of fish with electricity. European standard. https://standards.globalspec.com/std/282064/cen-en-14011.

Costa, W. J. E. M. (1992). Description de huit nouvelles espèces du genre *Trichomycterus* (Siluriformes: Trichomycteridae), du Brésil oriental. *Revue Française d'Aquariologie*, **18**,101–110.

Costa, W. J. E. M. (1994). A new genus and species of Sarcoglanidinae (Siluriformes: Trichomycteridae) from the Araguaia basin, central Brazil, with notes on subfamilial phylogeny. *Ichthyological Exploration of Freshwaters*, **5**, 207–216.

Costa, W. J. E. M. (2016). Comparative morphology, phylogenetic relationships, and taxonomic revision of South American killifishes of the *Melanorivulus zygonectes* species group (Cyprinodontiformes: Rivulidae). *Ichthyological Exploration of Freshwaters*, **27**, 107–152.

Costa, W. J. E. M. & Bockmann, F. A. (1994). A new genus and species of Sarcoglanidinae (Siluriformes: Trichomycteridae) from southeastern Brazil, with a re-examination of subfamilial phylogeny. *Journal of Natural History*, **28**, 715–730.

Costa, W. J. E. M., Lima, S. M. Q. & Bizerril, C. R. S. F. (2004). *Microcambeva ribeirae* sp. n. (Teleostei: Siluriformes: Trichomycteridae): a new sarcoglanidine catfish from the Rio Ribeira do Iguape basin, southeastern Brazil. *Zootaxa*, **563**, 1–10.

Datovo, A. & Bockmann, F. A. (2010). Dorsolateral head muscles of the catfish families Nematogenyidae and Trichomycteridae (Siluriformes: Loricarioidei): comparative anatomy and phylogenetic analysis. *Neotropical Ichthyology*, **8**, 193–246.

Landim, M.I. & Costa, W.J.E.M. (2002). *Listrura tetraradiata* (Siluriformes: Trichomycteridae): a new glanapterygine catfish from the southeastern Brazilian coastal plains. *Copeia*, **2002**, 152–156.

Lujan, N. K. & Chamon, C. C. (2008). Two new species of Loricariidae (Teleostei: Siluriformes) from main channels of the upper and middle Amazon Basin, with discussion of deep water specialization in loricariids. *Ichthyological Exploration of Freshwaters*, **19**, 271–282.

Lundberg, J. G. & Py-Daniel, L. R. (1994). *Bathicetopsis oliveirai*, gen. et sp. nov., a blind and depigmented catfish (Siluriformes: Cetopsidae) from the Brazilian Amazon. *Copeia*, **1994**, 381–390.

Mattos, J. L. O., Costa, W. J. E. M. & Gama, C. S. (2008). A new miniature species of *Ammoglanis* (Siluriformes: Trichomycteridae) from the Brazilian Amazon. *Ichthyological Exploration of Freshwaters*, **19**, 161–166.

Mattos, J. L. O., Costa, W. J. E. M. & Santos, A. C. A. (2015). *Geophagus multidentatus*, a new species of the *G. brasiliensis* species group from Chapada Diamantina, north-eastern Brazil (Cichlidae: Geophagini). *Ichthyological Exploration of Freshwaters*, **26**, 209–220.

Mattos, J. L. O. & Lima, S. M. Q. (2010). *Microcambeva draco*, a new species from northeastern Brazil (Siluriformes: Trichomycteridae). *Ichthyological Exploration of Freshwaters*, **21**, 233–238.

Myers, G. S. & Weitzman, S. H. (1966). Two remarkable new trichomycterid catfishes from the Amazon basin in Brazil and Colombia. *Journal of Zoology*, **149**, 277–287.

Pinna, M. C. C. de (1989a). A new sarcoglanidine catfish, phylogeny of its subfamily, and an appraisal of the phyletic status of the Trichomycterinae (Teleostei, Trichomycteridae). *American Museum Novitates*, **2950**, 1–39.

Pinna, M. C. C. de (1989b). Redescription of *Glanapteryx anguilla*, with notes on the phylogeny of Glanapteryginae. *Proceedings of the Academy of Natural Sciences of Philadelphia*, **141**, 361–374.

Pinna, M. C. C. de & Kirovsky, A. L. (2011). A new species of sand-dwelling catfish, with a phylogenetic diagnosis of *Pygidianops* Myers (Siluriformes: Trichomycteridae: Glanapteryginae). *Neotropical Ichthyology*, **9**, 493–504.

Pinna, M. C. C. de & Starnes, W. C. (1990). A new genus and species of Sarcoglanidinae from the Río Mamoré, Amazonas Basin, with comments on subfamilial phylogeny (Teleostei, Trichomycteridae). *Journal of Zoology*, **222**, 75–88.

Pinna, M. C. C. de & Winemiller, K. O. (2000). A new species of *Ammoglanis* (Siluriformes: Trichomycteridae) from Venezuela. *Ichthyological Exploration of Freshwaters*, **11**, 255–264.

Pinna, M. C. C. de & Zuanon, J. (2013). The genus *Typhlobelus*: monophyly and taxonomy, with description of a new species with a unique pseudotympanic structure (Teleostei: Trichomycteridae). *Copeia*, **2013**, 441–453.

Schaefer, S. A., Provenzano, F., Pinna, M. de & Baskin, J. N. (2005). New and noteworthy Venezuelan glanapterygine catfishes (Siluriformes, Trichomycteridae), with discussion of their biogeography and psammophily. *American Museum Novitates*, **3496**, 1–27.

Taylor, W. R. & Van Dyke, G. C. (1985). Revised procedures for staining and clearing small fishes and other vertebrates for bone and cartilage study. *Cybium*, **9**, 107–109.

Villa-Verde, L., Lazzarotto, H. & Lima, S. M. Q. (2012). A new glanapterygine catfish of the genus *Listrura* (Siluriformes: Trichomycteridae) from southeastern Brazil, corroborated by morphological and molecular data. *Neotropical Ichthyology*, **10**, 527–538.

Wosiacki, W. B., Coutinho, D. P. & Montag, L. F. A. (2011). Description of a new species of sand-dwelling catfish of the genus *Stenolicmus* (Siluriformes; Trichomycteridae). *Zootaxa*, **2752**, 62–68.

Zuanon, J. & Sazima, I. (2004). Natural history of *Stauroglanis gouldingi* (Siluriformes: Trichomyteridae), a miniature sand-dwelling candiru from central Amazonian streamlets. *Ichthyological Exploration of Freshwaters*, **15**, 201–208.

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