



Universidade Federal do Maranhão

Programa de Pós-Graduação em Biodiversidade e Conservação

**ESTUDO TAXONÔMICO DA FAMÍLIA CHARACIDAE DA DRENAGEM DO
RIO PINDARÉ, BACIA DO RIO MEARIM, MARANHÃO, NORDESTE DO
BRASIL**

SÃO LUÍS – MA

2018

ERICK CRISTOFORO GUIMARÃES

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Dissertação apresentada ao Programa de Pós-graduação em Biodiversidade e Conservação da Universidade Federal do Maranhão, como requisito parcial para a obtenção do título de Mestre em Biodiversidade e Conservação.

Orientador (a): Prof. Dr.: Felipe Polivanov Ottoni

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Aprovado em ____/____/____

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LISTA DE SIGLAS E ABREVIATURAS

CICCAA - Coleção Ictiológica do Centro de Ciências Agrárias Ambientais, da Universidade Federal do Maranhão.

CM - Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, U.S.A; and

CNPq - Conselho Nacional de Desenvolvimento Científico e Tecnológico – Ministério da Ciência e Tecnologia.

CPUFMA - Coleção de Peixes da Universidade Federal do Maranhão

FAPEMA - Fundação de Amparo à Pesquisa e Desenvolvimento Científico do Maranhão.

IBAMA – Instituto Brasileiro de Meio Ambiente

MCP - Museu de Ciências e Tecnologia, Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre

MHNM - Museo Nacional de Historia Natural y Antropología, Zoología, Seccion Ictiología, Ministerio de Educación y Cultura, Montevideo, Uruguay

SISBIO – Sistema de informação da Biodiversidade

UFRJ - Coleção Ictiológica do Instituto de Biologia, Universidade Federal do Rio de Janeiro. Rio de Janeiro

USMN - Smithsonian Institution National Museum of Natural History, Washington D.C., U.S.A

APRESENTAÇÃO

A presente dissertação está estruturada consoante às normas do Programa de Pós-Graduação em Biodiversidade e Conservação da Universidade Federal do Maranhão. (Artigo 47 do regimento interno do Programa de Pós-Graduação em Biodiversidade e Conservação, da Universidade Federal do Maranhão).

A dissertação está organizada em três capítulos: o primeiro - **“A Família Characidae: introdução geral”** - traz um breve comentário e histórico sobre o atual conhecimento taxonômico e sistemático da família; o segundo - **“New species of the *Charax* (Characiformes: Characidae) from the Mearim river basin, Brazil”** - descreve uma nova espécie do gênero *Charax* para bacias costeiras do Estado do Maranhão; o terceiro - **“An annotated and illustrated checklist of Characidae (Characiformes) from the Pindaré river, Mearim river basin, northeastern Brazil”** contempla um estudo taxonômico das espécies da Família Characidae que ocorrem na drenagem do rio Pindaré, Bacia do Mearim, nordeste do Brasil.

RESUMO

Um dos principais desafios na ictiologia Neotropical moderna refere-se à sistemática de Characidae, uma família com aproximadamente 1.200 espécies válidas, correspondendo à aproximadamente dois terços da diversidade de Characiformes. Characidae também é a família de Characiformes mais amplamente distribuída, com representantes ocorrendo desde o sul dos Estados Unidos, até a Patagônia na Argentina e o no centro do Chile. A maior parte da diversidade da família, contudo, concentra-se do Panamá ao sistema do rio da Prata, e, mais particularmente, nas bacias do norte da América do Sul cis-andina (bacia amazônica, rios guianenses e bacia do rio Orinoco). Com a finalidade de se realizar um estudo taxonômico das espécies de Characidae presentes na drenagem do rio Pindaré da bacia do Mearim, nordeste do Brasil, foram realizadas 14 campanhas de amostragens no período de 2012 à 2018. O rio Pindaré faz parte das drenagens costeiras do nordeste do Brasil, e está inteiramente incluída na região da Amazônia legal do Estado do Maranhão. No presente estudo, um total de 26.726 exemplares pertencentes a família Characidae foram coletados, sendo registrados 13 gêneros e 15 espécies. 11 aumentos de distribuição e descrição de uma nova espécie da família Characidae, são apresentadas, assim como informações sobre a taxonomia e distribuição das espécies.

Palavras chaves: Biodiversidade; Characiformes; Ictiologia; Taxonomia.

ABSTRACT

One of the main challenges of modern Neotropical ichthyology consists to the systematics of Characidae, a family with approximately 1.200 species valid, including about two thirds of all Characiformes diversity. Characidae is also the most widely distributed family of Characiformes, with representatives occurring from the south of the United States all to Argentinian Patagonia, and the center of Chile. However, most of this family's diversity is concentrated from Panama to the Plata River system, and, more particularly, in the northern cis-Andean South American basins (Amazonian basin, Guyana rivers and Orinoco River basin). With the objective of carrying out a taxonomic study of Characidae species found at the Pindaré River drainage of the Mearim River basin, northeastern Brazil, we conducted 14 sampling campaigns during a period from 2012 to 2018. The Pindaré river is part of the coastal drainages of northeastern Brazil, and it is entirely included in the Amazonia Legal region of the Maranhão state. In our study, a total of 26,726 specimens belonging to Characidae were collected, comprehending 13 genera and 15 species. We present here 11 distribution expansions and describe new Characidae species, as well as new data on species taxonomy and distribution.

Key-words: Biodiversity; Characiformes; Ichthyology; Taxonomy

CAPITULO I

A Família Characidae: introdução geral

Este capítulo é introdutório à dissertação e não será submetido à publicação

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Introdução

Atualmente são conhecidas aproximadamente 60.000 espécies de vertebrados. Dentre essas 60.000 espécies destacam-se os peixes, com cerca de 34.000 espécies atuais consideradas como válidas; sendo 56% das espécies marinhas, 43% dulcícolas e 1% movendo-se entre água doce e salgada durante seu ciclo de vida (NELSON et al., 2016; FRICKE et al., 2018). Essa grande riqueza de espécies de peixes reflete-se também em sua diversidade morfológica e ecológica (NELSON et al., 2016). Os habitats de água doce constituem apenas uma pequena proporção da água de superfície terrestre, mas contêm um número desproporcionalmente grande de espécies de peixes (NELSON et al., 2016).

Devido às muitas descrições recentes de novas espécies de peixes de água doce e marinhos, a diversidade conhecida tem vindo a aumentar a cada ano (FRICKE et al., 2018). Dentre as principais linhagens atuais de peixes destacam-se a subclasse Actinopterygii (peixes de nadadeiras raiadas) com mais de 30.500 espécies atuais, incluindo grande maioria das espécies atuais conhecidas; e a Classe Chondrichthyes (peixes cartilaginosos) com aproximadamente 1.200 espécies atuais (NELSON *et al.*, 2016).

A América do Sul é o principal continente do mundo quando falamos sobre biodiversidade de peixes, sendo o continente com a ictiofauna mais diversa, com estimativas atuais de mais de 9.100 espécies válidas ocorrendo em ambientes de água doce e regiões marinhas próximas à costa (27% das espécies de peixes do mundo) (REIS et al., 2016). A ictiofauna de água doce do continente é mais rica do que a ictiofauna marinha, possuindo cerca de 5.160 espécies descritas (cerca de um terço de todos dos peixes de água doce do mundo). A ictiofauna marinha da América do Sul compreende pouco menos de 4.000 espécies, correspondendo a cerca de 23% do número de espécies de peixes marinhos do mundo (REIS et al., 2016). A publicação da Lista de dos Peixes de Água Doce que ocorrem na América do Sul e América Central (CLOFFSCA) (REIS et al., 2003) listou cerca de 4.500 espécies válidas para a região Neotropical, estimando que ainda havia cerca de 1.550 espécies não descritas. Entretanto, novas estimativas apontam que a diversidade da ictiofauna dulcícola da região Neotropical possa ser muito maior, na ordem de oito à nove mil espécies (REIS et al., 2016), estimativa similar a proposta por Schaefer (1998). Uma média de 104 novas espécies, desde a publicação do CLOFFSCA acima citado, foram descritas a cada ano para América do Sul, totalizando

1.352 novas espécies. Resumidamente, cerca de 30% da ictiofauna conhecida da América do Sul foi descrita nos últimos 13 anos, segundo REIS et al. (2016).

O Brasil concentra as maiores redes hidrográficas da região Neotropical, as quais apresentam elevada biodiversidade aquática, compreendendo 21% das espécies de peixes de água doce do mundo (BUCKUP et al., 2007). Sendo assim, estima-se que ocorram aproximadamente 2.600 espécies dulcícolas de peixes em território brasileiro (REIS et al., 2003; BUCKUP et al., 2007). A maior parte dessa diversidade corresponde a espécies de pequeno e médio porte, que estão distribuídas principalmente em riachos (LOWE-MCCONNELL, 1999).

Contudo, a cada ano o número de novas espécies descritas e novos registros de distribuição vem aumentando exponencialmente, indicando que são necessários mais estudos e pesquisas direcionadas a taxonomia, estimativas de biodiversidade (inventários) e distribuição dos peixes neotropicais. Além da falta de conhecimento sobre os grupos, a rápida perda e degradação dos ambientes naturais são uma grande ameaça, principalmente considerando que parte das espécies se distribuem por áreas restritas, e muitas delas são endêmicas (REIS et al., 2003; NOGUEIRA et al., 2010).

A Ordem Characiformes é um dos componentes da fauna aquática com o maior número de espécies, com aproximadamente 3.700 espécies válidas (FRICKE et al., 2018). Os Characiformes estão presentes nas regiões biogeográficas Etiópica e Neotropical; na Região Neotropical havendo representantes do sudoeste dos Estados Unidos ao norte da Patagônia (FRICKE et al., 2018). As espécies dessa ordem habitam rios e riachos, ambientes lóticos e lênticos, águas límpidas e turvas (FRICKE et al., 2018). Compreendem as mais diversas formas, desde espécies miniaturas que não ultrapassam 15 mm de comprimento padrão na fase adulta, a espécies com mais de 100 cm (e.g. *Salminus* Agassiz 1829); e desde espécies predadoras, com dentes afiados, como as traíras (*Hoplias* Gill 1903), a espécies sem dentes (e.g. *Curimatopsis* Steindachner 1876).

Dentro dessa Ordem, destaca-se a família Characidae, por ser mais diversa e a mais problemática em termos taxonômicos, com cerca de 1.200 espécies atualmente consideradas como válidas, (representando aproximadamente 32% das espécies dentre os Characiformes), é a quarta família mais diversa de peixes, atrás apenas de Gobiidae, Cichlidae e Cyprinidae ((FRICKE et al., 2018). Characidae também é a família de Characiformes mais amplamente distribuída, com representantes ocorrendo desde o sul dos Estados Unidos, até a Patagônia na Argentina e no centro do Chile (GUIMARÃES et

al. 2018). A maior parte da diversidade da família, contudo, concentra-se do Panamá ao sistema do rio da Prata, e mais particularmente, nas bacias do norte da América do Sul cis-andina (bacia amazônica, rios guianenses e bacia do rio Orinoco) (NELSON *et al.*, 2016).

Neste trabalho, será apresentado o aumento de distribuição, descrições de espécies novas, identificação das espécies da família que ocorrem na drenagem estudada até o menor nível taxonômico possível, referências sobre as descrições originais e sinonímias, depósito do exemplar-tipo, localidade-tipo, comentários taxonômicos e de distribuição, além de fotos, preferencialmente em vida, sempre que possível.

Fundamentação Teórica

Uma revisão histórica dos conceitos filogenéticos dentro da Ordem Characiformes foi apresentada por Vari (1998). Segundo o autor, publicações tratando aspectos filogenéticos de Characiformes eram raras até a década de 1950, abordando a maioria dos autores questões centradas em subunidades menores dentro da Ordem.

Os trabalhos publicados nas décadas de 1950 e 1960 (e.g. WEITZMAN, 1954, 1960) estabeleceram um novo padrão de estudo para o grupo, que passou a considerar, além dos caracteres de morfologia externa e de dentição, a osteologia e anatomia interna. Esse tipo de abordagem aliado a nascente metodologia cladística de Henning (1950, 1966) permitiu que os estudos morfológicos se transformassem em hipótese de relações filogenéticas testáveis, o que contribuiu significativamente para o avanço dos estudos das relações de parentesco em Characiformes (VARI, 1998).

Géry (1977) publicou uma obra contendo a maioria das espécies até então conhecidas para a Ordem e suas prováveis relações. No entanto, o trabalho que, de fato, tratou de uma ampla análise filogenética em Characiformes foi realizado por Buckup (1998), como a primeira hipótese filogenética de Characiformes utilizando explicitamente a metodologia cladística.

Characidae é uma das maiores famílias de peixes (NELSON *et al.*, 2016). Lima *et al.* (2003) estabeleceram 88 gêneros desta família como incertae sedis. Atualmente, esses gêneros compreendem mais de 700 espécies, sendo a maioria pertencentes a seis gêneros: *Astyanax* Baird & Girard 1854 (137 espécies), *Hyphessobrycon* Durbin 1908 (127 espécies), *Moenkhausia* Eigenmann 1903 (75 espécies), *Bryconamericus* Eigenmann

1907 (73 espécies), *Creagrutus* Günther 1864 (69 espécies), *Hemigrammus* Gill 1858 (54 espécies).

Todos estes gêneros são, provavelmente, não monofiléticos (LIMA et al., 2003). Estes, juntos com outros gêneros menores, também alocados como *incertae sedis* em Characidae, compunham, até o trabalho de Reis et al. (2003), a subfamília Tetragonopterinae.

A retirada desses gêneros de Tetragonapterinae e a designação como *incertae sedis* causou discórdia entre alguns autores. Géry e Zarske (2004) criticaram severamente esse posicionamento, defendendo que a alocação em Tetragonapterinae era a mais aceita até aquele momento, que foi aprovada por diversos autores precedentes e que a alocação em *incertae sedis* nada contribuiria para o esclarecimento das relações filogenéticas do grupo. Desde então, novas relações vem sendo propostas.

Mirande (2009) propôs uma hipótese para classificação de Characidae embasada em análises filogenéticas a partir de caracteres morfológicos. A hipótese confirma a monofilestimo da família e apresenta redefinições para suas subfamílias, muito embora não apresente as sinapomorfias sustentando grande parte dos seus clados.

Um ano mais tarde, Mirande (2010) redefiniu e adicionou caracteres ao trabalho anterior, apresentando a mais extensiva análise cladística baseada em caracteres morfológicos das relações dentro de Characidae até aquele momento. O autor teve como base 360 caracteres de 160 espécies de Characiformes, sendo 145 do grupo interno Characidae (60 gêneros de Characidae e as famílias Alestidae, Chilodontidae, Citharinidae, Ctenoluciidae e Hepsetidae não foram incluídas na análise).

Oliveira et al. (2011) sugerem uma composição mais restrita da família, com base em evidências morfológicas e moleculares. Ao analisarem espécies representantes de todas as famílias e subfamílias de Characiformes [seguindo REIS et al. (2003)] e mais 56 espécies em *incertae sedis*. Iguanodecinae apareceu em outro clado como grupo-irmão de *Bryconops* Kner 1858. E os autores propuseram que *Iguanodectes* Cope 1872, *Piabucus* Oken 1817 e *Bryconops* fossem unidos na família Iguanodectidae.

Mirande (2016) redefiniu e adicionou caracteres ao trabalho anterior, apresentando a análise cladística mais completa de peixes (Actinopterygii) até o momento. O autor teve

como base 44 marcadores de DNA nuclear e mitocondrial e 274 caracteres morfológicos de 8.104 espécies de Actinopterygii. Os resultados gerais concordam com classificações anteriores, especialmente para grupos com melhor amostragem de genes. Entretanto o autor ressalta a necessidade de dados e estudos sintéticos de homologia para obter sinapomorfias e diagnósticos para a maioria dos clados.

Dois ano mais tarde, Mirande (2018) realizou a análise filogenética mais abrangente dos Characidae até hoje e a primeira hipótese em larga escala da família, combinando dados morfológicos com informações moleculares. Um total de 520 caracteres morfológicos foram analisados. O número total de espécies no conjunto de dados analisado é 473. As análises foram feitas por parcimônia sob ponderação implícita igual e estendida com uma ampla gama de parâmetros. A hipótese resultante é congruente com filogenias de base molecular da família. Os Characidae são monofiléticos, com quatro clados principais: Spintherobolinae nova subfamília; um Stethaprioninae expandido incluindo o Grundulini, Gymnocharacini, Rhoadsiini e Stethaprionini; o Stevardiinae; e um clado composto de Aphyocharacinae, Characinae, Cheirodontinae, Exodontinae e Tetragonopterinae.

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CAPÍTULO II

New species of the *Charax* (Characiformes: Characidae) from the Mearim river basin, Brazil

Zoosystematics and Evolution

Status: published

A new species of *Charax* (Ostariophysi, Characiformes, Characidae) from northeastern Brazil

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Abstract

Charax awa sp. nov. is herein described from the Rio Mearim, Rio Munim and Rio Turiaçu basins, three coastal river basins of northeastern Brazil located between the Rios Gurupi and Parnaíba basins. These have a complex and still poorly known biogeographic history. This region is ecologically extremely relevant since it comprises three of the main Brazilian biomes, as well as, transition zones between them: Amazônia, Brazilian Cerrado and Caatinga. Therefore, this area has faunal and floristic representatives of these three biomes, which makes it particularly relevant in terms of ecology, biodiversity and conservation. *Charax awa* sp. nov. possesses a relatively small orbital diameter (22.1–28.5% HL), what distinguishes it from most of its congeners, except from *C. notulatus* and *C. caudimaculatus*. It differs from *C. caudimaculatus* by a longer snout, and from *C. notulatus* by the number of scales around the caudal peduncle, as well as by the number of vertebrae. The new species herein described differs from its geographically closely distributed congeners, *C. leticiae*, *C. niger*, and *C. pauciradiatus* mainly by the relative horizontal orbital diameter. It is a "small-eyed" species. In addition, *C. awa* sp. nov. can be distinguished from *C. leticiae* by having a maxilla extending to the vertical line posterior to the pupil, near the posterior orbital margin and by having a lower humeral spot distance. It can be distinguished from *C. pauciradiatus* by more scale rows from the pelvic-fin origin to the lateral line and more scale rows from the dorsal-fin origin to the lateral line and it differs from *C. niger* by having more transverse scale rows in space from the humeral spot to the supracleithrum. In addition, it differs from *C. pauciradiatus* and *C. niger* by the absence of bony hooks on anal and pelvic-fins rays of adult males.

Keywords

Characinae, Characini, freshwater, Maranhão state, Neotropical region, Rio Mearim, Rio Munim, Rio Turiaçu, taxonomy

Introduction

Characidae is the most species-rich family of Characiformes, comprising about 165 genera and more than 1.150 species, distributed along the river systems between southwestern Texas and Mexico in North America and Patagonia in southern South America (Eschmeyer et al. 2017). *Charax* Scopoli, 1777 is a South American characid genus possessing a midsized (maximum size about 130.0 mm SL) and deep body, being the type genus of the Characidae, comprising 16 valid species (Menezes and Lucena 2014), widely distributed in the Cis-Andean region, occurring in the Amazonas, Paraná, Uruguay, Paraguay, Capim, and Orinoco river basins, as well as in smaller isolated river basins draining the Guiana Shield, and in the Lagoa dos Patos system, and other coastal lagoons of southern Brazil (Menezes and Lucena 2014).

The distribution of the genus is mainly concentrated in central and northern South America; there is no record for eastern Brazil and none of the valid species was assigned for the coastal river basins of northeastern Brazil by the recent taxonomic revision of the genus (see Menezes and Lucena 2014). However, some records of *Charax* for the coastal river basins of northeastern Brazil were made before the taxonomic revision made by Menezes and Lucena (2014): Martins and Oliveira (2011) recorded *C. gibbosus* for the Rio Mearim basin; Barros et al. (2011) recorded *Charax* sp. for the Rio Itapecuru basin; Martins and Oliveira (2011) recorded *Charax* sp. for the Rio Pericumã basin and Rio Mearim basin.

Charax can be distinguished from all other characid genera by the presence of a deep concavity on the latero-ventral portion of the cleithrum originating a relatively long posterior spiniform projection extending below pectoral-fin base; and an anterior shorter process oriented straight forward or either inclined or bent laterally (Lucena 1987, Mattox and Toledo-Piza 2012: Fig 34, Menezes and Lucena 2014). A new species of *Charax* is herein described from the Rio Mearim, Rio Munim and Rio Turiaçu basins, three coastal river basins of northeastern Brazil.

Material and methods

Counts and measurements were taken according to Fink and Weitzman (1974), Menezes and Weitzman (1990) and Menezes and Lucena (2014), on the left side of specimens whenever possible, using a digital caliper with precision of 0.01 mm. Measurements are given as a percentage of standard length (SL), except for subunits of the head, which are given as a percentage of head length (HL). Vertebrae of the Weberian apparatus were counted as four elements and included in the vertebral counts, whereas the fused PU1+U1 of the caudal region was counted as a single element. Counts for supraneurals, vertebrae, rib pairs, branchiostegal rays, gill-rakers, premaxillary, maxillary, and dentary teeth, procurent caudal-fin rays, and pterygiophores were taken only from cleared and stained

paratypes, prepared according to Taylor and Van Dyke (1985); number of examined specimens are in parentheses. Osteological nomenclature follows Weitzman (1962). Diagnosis was made based on a unique combination of character states, according to Davis and Nixon (1992). Information about congeners was based on both comparative material and literature (e.g Lucena 1987, Mattox and Toledo-Piza 2012, Menezes and Lucena 2014). Institutional abbreviations are: **CICCAA** Coleção Ictiológica do Centro de Ciências Agrárias Ambientais, Universidade Federal do Maranhão, Chapadinha; **CPUFMA** Coleção de Peixes da Universidade Federal do Maranhão, São Luís; **UFRJ** Coleção Ictiológica do Instituto de Biologia, Universidade Federal do Rio de Janeiro. Rio de Janeiro; **MCP** Museu de Ciências e Tecnologia, Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre; **USMN** Smithsonian Institution National Museum of Natural History, Washington D.C., U.S.A; **CM** Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, U.S.A; and **MHNM** Museo Nacional de Historia Natural y Antropología, Zoología, Sección Ictiología, Ministerio de Educación y Cultura, Montevideo, Uruguay.

Results

Charax awa sp. nov.

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Fig. 1.

Charax gibbosus [*non Charax gibbosus* (Linnaeus, 1758)]: Martins and Oliveira, 2011: 196-197.

Charax sp. - Martins and Oliveira, 2011:196-197.

Holotype. CICCAA 00752, 101.3 mm SL, Brazil: Maranhão State: Alto Alegre do Pindaré municipality: Igarapé Mineirão, Rio Mearim basin, 3°42'26"S, 45°56'5"W; Guimarães E. C. and Costa C.H.; 03 Dec. 2015.

Paratypes. All from Maranhão State, Brazil: CICCAA 00248, 9, 47.7-90.6 mm SL; CICCAA 00249, 6 (C&S), 42.6-73.8 mm SL; CICCAA 00754, 2, 55.2-68.7 mm SL; collected with holotype. CICCAA 00753, 1 (C&S), 41.4 mm SL, Rio Zutuia (Rio Mearim basin), Santa Inês municipality, 3°43'48"S 45°35'7"W; Guimarães E. C. and Costa C.H.; 03 Dec 2015. CICCAA 00766, 1 (C&S), 78.5 mm SL, Rio Zutuia (Rio Mearim basin), Santa Inês municipality, 3°43'48"S 45°35'7"W; Guimarães E. C. and Costa C.H.; 03 Dec 2015. CICCAA 00755, 1, 59.8 mm SL stream at the Santa Inês municipality (Rio Mearim basin), Santa Inês municipality, 3°40'48"S 45°19'51"W; Guimarães E. C. and Costa C.H.; 03 Dec 2015. CICCAA 00896, 2, 40.2-48.8 mm SL stream Arapapá (Rio Mearim basin), Alto Alegre municipality; 3°42'30"S 46° 0'19"W; Guimarães E. C. and Brito P. S; 15 Ago 2017. CICCAA 00765, 11, 44.4-68.3 mm SL Lirio stream (Rio Mearim basin), Alto Alegre municipality; 3°38'56"S 45°46'18"W; Guimarães E. C. and Brito P.S; 15 Ago 2017. CICCAA 00764, 5, 68.4-89.3 mm SL, Olho d'água dos Carneiros (Rio Mearim basin), Santa Inês municipality; 3°43'0"S 45°28'36"W; Guimarães E. C. and Brito P.S; 11 Ago 2017. CICCAA 00898, 1, 62.2 mm SL, stream at Miranda do Norte municipality (Rio Mearim basin), 3°31'30"S 44°35'6"W; Guimarães E. C. and Brito P.S.; 13 Ago 2017. UFRJ11696, 2, 69.9-70.6 mm SL stream Arapapá (Rio Mearim basin), Alto Alegre municipality; 3°42'30"S 46° 0'19"W; Guimarães E. C. and Brito P.S; 15 Ago 2017. MCP

52700, 4, 45.9-75.1 mm SL Arapapá stream (Rio Mearim basin), Alto Alegre municipality; 3°42'30"S 46° 0'19"W; Guimarães E. C. and Brito P.S; 15 Ago 2017. CPUFMA 98859, 40, 52.2-120.0 mm SL, Rio Turiaçu, (Rio Turiaçu basin), Santa Helena municipality; 2°27'35"S 45°30'42"W; Piorski et al. 8 Ago 1998. CPUFMA 001747, 18, 76.9-117.3 mm SL, Rio Turiaçu, (Rio Turiaçu basin), Santa Helena municipality; 2°27'35"S 45°30'42"W; Piorski et al. 17 Abr 2000. CPUFMA 112036, 4, 88.5–88.7 mm SL, Rio Munim, Chapadinha municipality; 3°50'19"S 43°19'46"W; Nunes et al. 8 Jul 2011. CPUFMA 98136, 3, 85.2-93.7 mm SL, Lago de Viana (Rio Mearim basin), Cajari municipality; 3°22'48"S 45°2'57"W; Piorski e Pereira, 17 Mar 1998. CPUFMA 98135, 3, 85.6-91.4 mm SL, Lago de Viana (Rio Mearim basin), Cajari municipality; 3°18'54"S 45° 1'40"W; Piorski e Pereira, 17 Mar 1998. CPUFMA 98137, 1, 88.2 mm SL, Lago de Viana (Rio Mearim basin), Viana municipality; 3°15'9"S 45°4'48"W; Piorski e Pereira, 14 Mar 1998. CPUFMA 97130, 1, 91.3 mm SL, stream Engenho (Rio Mearim basin), Viana municipality; 3°12'26"S 44°58'5"W; Piorski e Pereira, 6 Dez 1997.

Non type material. All from Maranhão State, Brazil: CPUFMA 98861, 24, 83.5-120.0 mm SL, Rio Turiaçu, (Rio Turiaçu basin), Santa Helena municipality; 2°27'35"S 45°30'42"W; Piorski et al. 8 Ago 1998. CPUFMA 98862, 23, 79.4-119.1 mm SL, Rio Turiaçu, (Rio Turiaçu basin), Santa Helena municipality; 2°27'35"S 45°30'42"W; Piorski et al. 14 Ago 1998. CPUFMA 00863, 25, 68.0-113.1 mm SL, Rio Turiaçu, (Rio Turiaçu basin), Santa Helena municipality; 2°27'35"S 45°30'42"W; Piorski et al. 21 Ago 2000. CPUFMA 00864, 43, 72.3-113.9 mm SL, Rio Turiaçu, (Rio Turiaçu basin), Santa Helena municipality; 2°27'35"S 45°30'42"W; Piorski et al. 16 Out 2000. CPUFMA 00865, 11, 82.3-114.2 mm SL, Rio Turiaçu, (Rio Turiaçu basin), Santa Helena municipality; 2°27'35"S 45°30'42"W; Piorski et al. 21 Ago 2000. CPUFMA 00866, 31, 82.6-110.3 mm SL, Rio Turiaçu, (Rio Turiaçu basin), Santa Helena municipality; 2°27'35"S 45°30'42"W; Piorski et al. 15 Out 2000. CPUFMA 00867, 16, 88.7-102.12 mm SL, Rio Turiaçu, (Rio Turiaçu basin), Santa Helena municipality; 2°27'35"S 45°30'42"W; Piorski et al. 22 Jun 2000.

Diagnosis

Charax awa sp. nov. can be distinguished from *C. apurensis* Lucena, 1987, *C. condei* (Géry & Knöppel, 1976), *C. delimai* Menezes & Lucena, 2014, *C. gibbosus* (Linnaeus, 1758), *C. hemigrammus* (Eigenmann, 1912), *C. leticiae* Lucena, 1987, *C. macrolepis* (Kner, 1858), *C. metae* Eigenmann, 1922, *C. michaeli* Lucena, 1989, *C. niger* Lucena, 1989, *C. pauciradiatus* (Günther, 1864), *C. stenopterus* (Cope, 1894) *C. tectifer* (Cope, 1870) by the orbital diameter (22.1–28.5% HL vs. 29.6–38.4% HL combined) (Fig. 2). *Charax awa* sp. nov. differs from *C. caudimaculatus* Lucena, 1987 by the possession of a longer snout (snout length 23.3–32.8% HL vs. 20.3–22.8% HL); from *C. notulatus* Lucena, 1987 by the number of scales around the caudal peduncle (15–18 vs. 20-22) and by having more vertebrae (35 vs. 32). Furthermore, *Charax awa* sp. nov. can be distinguished from *C. condei*, *C. hemigrammus* and *C. stenopterus* by having the lateral line complete (vs. incomplete); from *C. delimai*, *C. metae* and *C. tectifer* by having a toothless ectopterygoid (vs. presence of teeth on ectopterygoid) and having the anal-fin origin always anterior to the vertical through the dorsal-fin origin (vs. anal-fin origin on, or slightly posterior to the vertical through the dorsal-fin origin); from *C. condei*, *C. delimai*, *C. hemigrammus*, *C. metae*, *C. pauciradiatus* and *C. stenopterus* by the number

of scale rows from the pelvic-fin origin to the lateral line (11–12 vs. 6–10 combined); from *C. pauciradiatus* by having more scale rows from the dorsal-fin origin to the lateral line (15–18 vs. 13–14). It can be distinguished from *C. niger* by having 8–10 transverse scale rows in space from the humeral spot to the supracleithrum (vs. 5–6); from *C. condei*, *C. delimai*, *C. metae*, *C. rupununi* Eigenmann, 1912 by the number of scale rows around the caudal peduncle (15–18 in *C. awa* sp. nov. vs. 12–14 combined in *C. condei* and *C. rupununi*, 19–21 combined in *C. delimai* and *C. metae*). Finally, it differs from *C. leticiae* by having the maxilla extending to a vertical line posterior to pupil, near the posterior orbital margin (vs. maxilla extending slightly beyond vertical through middle of pupil) and from humeral spot distance (35.8–38.0 % SL vs. 39.0–44.0 % SL).

Description

Morphometric data are presented in Tables 1 and 2. Body moderately large (40.2–120.0 mm SL), compressed and moderately deep; greatest body depth slightly in advance of dorsal-fin origin. Dorsal profile of head and body slightly convex on tip of snout, approximately straight from posterior border of posterior nostril to vertical line through posterior border of pupil, concave from that point to about half of distance between pupils and posterior margins of preopercle, strongly convex from that point to dorsal-fin origin, nearly straight along dorsal-fin base and from end of dorsal-fin base to caudal peduncle and slightly concave along caudal peduncle. Ventral profile of head and trunk convex from tip of lower jaw to anal-fin origin, nearly straight along anal-fin base and slightly concave from end of anal-fin base to beginning of procurrent rays. Snout pointed. Lower jaw included in upper jaw when mouth closed. Maxilla extending to a vertical line posterior to pupil, near the posterior orbital margin. Small triangular posteriorly directed projection at intersection between dorsal and posterior margins of hyomandibular (Mattox and Toledo-Piza 2012: Figs 24A, 25B).

Dorsal-fin rays ii, 9 (72). Dorsal-fin pterygiophores 10 (8); first dorsal-fin pterygiophore between 4th and 5th vertebrae. Adipose fin present. Unbranched anal-fin rays iv (74) or v (1), branched rays 46 (4), 47 (5), 48 (10), 49 (13), 50 (9), 51 (6), 52 (13), 53 (5), 54 (2) or 56 (1). Anal-fin pterygiophores 46 (2), 47 (2), 48 (1), 49 (2) or 50 (1); first anal-fin pterygiophore between 7th and 8th vertebrae. Pectoral-fin rays i, 13 (3) or 14 (22). Tips of longest pectoral-fin rays reaching slightly beyond middle of pelvic-fin length. Pelvic-fin rays i, 7 (64) or i, 8 (2). Axilar scale on pelvic fin absent. Tips of longest pelvic-fin rays reaching anal-fin rays, between bases of second to seventh branches. Principal caudal-fin ray count 10/9 (59). Dorsal procurrent caudal-fin rays 12 (1), 14 (2), 15(1), 16 (2) or 17 (2). Ventral procurrent caudal-fin rays 7 (3), 8 (2), 9 (1), 1 (10) or 11 (1).

Ventral-most longitudinal series of scales on each side of trunk overlapping one another, delimiting longitudinal gap on region anterior to anus. Scale sheath along anal-fin base. Scales on caudal fin restricted to base of rays. Lateral line complete; perforated scales 53 (1), 54 (3), 55 (8), 56 (10), 57 (4), 58 (2), 59 (4), 60 (7), 61 (4), 62(3) or 63 (1). Horizontal scale rows between dorsal-fin origin and lateral line 15 (27), 16 (20), 17 (5) or 18 (3). Horizontal scale rows between pelvic-fin origin and lateral line 11 (66) or 12 (4).

Horizontal scale rows between anal-fin origin and lateral line 12 (2), 13 (37), 14 (16), 15 (7) or 16 (1). Scale rows around caudal peduncle 15 (4), 16 (26), 17 (13) or 18 (3). Scale row along anal-fin base, extending for about two thirds of fin base. Predorsal scales 49 (1), 50 (6), 52 (9), 53 (5), 54(7), 55(3), 56(3), 57 (1), 58 (1), 59 (1), 60 (1), 62 (4), 63 (2), 64 (1), 66 (1), 68 (2). Transverse scale rows between humeral spot and supracleithrum 8 (57), 9 (16) or 10 (1).

Premaxilla and dentary with two canine-like teeth and remaining teeth conical. Maxilla with all teeth conical. Premaxilla with one anterior canine-like tooth followed by set of smaller conical teeth, another canine-like tooth placed on posterior portion of bone, followed by one or two small conical teeth (Fig. 2). Total number of premaxillary teeth 13 (4), 14 (3) or 15 (1). Maxilla with 52 (1), 55 (4), 58 (2) or 60 (1) teeth. Dentary with one canine-like tooth followed by 3-4 conical teeth, another canine-like tooth followed by a posterior row of 16 (3), 18 (4) or 19 (1) conical teeth (Fig. 2).

Ectopterygoid and metapterygoid without teeth. Gill-rakers on lower limb of first gill-arch 13 (2), 14 (3). Branchiostegal rays 3 (1) or 4 (7). Supraneurals 4 (8); first supraneural inserted posterior to neural spine of 4th centrum, and last supraneural inserted anterior to first dorsal-fin pterygiophore. Precaudal vertebrae 12 (8). Caudal vertebrae 23 (8). Total vertebrae 35 (8). Pleural rib pairs 11 (8). Pre- and postzygapophyses minute, approximately triangular in shape, and positioned somewhat parallel to neural zygapophysis of adjacent vertebra (e.g. Mattox and Toledo-Piza 2012: Fig. 32A).

Color in alcohol

Body pale yellow to light yellow, slightly darker dorsally. Both extreme dorsal and ventral regions of trunk with scattered dark chromatophores. Inconspicuous approximately rounded or slightly elliptical dark brown humeral blotch, extending about three to four scales horizontally and about five vertically. Dorsal part of head, snout, circumorbital region and opercle darker than rest of head. Scattered dark chromatophores on tip of snout and suborbital region. V-shaped lines of chromatophores over myosepta along epaxial and hypaxial muscles, more visible on mid-posterior portion of body. Inconspicuous, approximately triangular shaped dark blotch on caudal-fin base, with posterior dark chromatophores. Inconspicuous clear stripe at anal-fin base. All fins hyaline, or light brown at base, with scattered dark chromatophores more visible on interradi al membranes. Anterior portion of first to third unbranched rays of dorsal and first unbranched rays of pectoral and pelvic-fin rays darker than remaining rays.

Color in life

Color pattern in life similar to coloration of preserved specimens. Body silver on, anterior portion, and silver to hyaline on posterior portion. Anterior and dorsal portions of trunk darker, and sides of head darker than rest of body. Humeral and caudal-fin base blotches inconspicuous. Dorsal margin of trunk with conspicuous dark brown chromatophores. Purple longitudinal stripe along mid-portion of flank, extending posteriorly to anterior margin of caudal-fin base. Fins hyaline, with scattered dark brown or black chromatophores, more visible on interradi al membranes.

Sexual dimorphism

No apparent sexual dimorphism.

Distribution

Charax awa is known from the Rio Mearim, Rio Munim and Rio Turiaçu basins, Maranhão state, northeastern Brazil (Fig. 3).

Remarks

The new species herein described differs from its geographically closely distributed congeners, *C. leticiae*, *C. niger*, and *C. pauciradiatus*, with records in the Lower Amazon, Capim, upper Itapecuru and Tocantins river basins (Fig. 4), mainly by the horizontal orbital diameter (see diagnosis section). In addition, *C. awa* sp.nov. can be distinguished from *C. leticiae* by having the maxilla extending to a vertical line posterior to pupil, near posterior orbital margin while *C. leticiae* shows the maxilla extending slightly beyond vertical through middle of pupil and by humeral spot distance (32.1–38.0 % SL vs. 39.0–44.0 % SL). It can be distinguished from *C. pauciradiatus* by possessing 11–12 scale rows from the pelvic-fin origin to the lateral line and 15–18 scale rows from the dorsal-fin origin to the lateral line, while *C. pauciradiatus* possess 6–10 and 13–14, respectively, and differs from *C. niger* by having 8–10 transverse scale rows in space from the humeral spot to the supracleithrum, while *C. niger* possess 5–6. Moreover, it differs from *C. pauciradiatus* and *C. niger* by the absence of bony hooks on anal and pelvic-fins rays of adult males. This last character is emphasized in the discussion section.

In addition, new species herein described differs from *C. gibbosus*, a species incorrectly identified for the same area of *C. awa* sp. nov. by the following features:

Charax awa sp.nov. possesses a toothless ectopterygoid, absence of bony hooks on anal-fin rays of mature males, 8–10 transverse scales rows between the humeral spot and the suprecleithrum and 49–68 predorsal scales; while *C. gibbosus* has teeth on ectopterygoid, bony hooks on anal-fin rays of mature males, 5–6 transverse scales rows between the humeral spot and the suprecleithrum, and 38–45 predorsal scales.

Etymology

The specific epithet honors the term *Awá*, from Tupi-guarani, meaning “man, people, person”, used by the native tribe Guajá, from the Maranhão state, for their self-denomination.

Discussion

Several authors have pointed out that *Charax* constitutes a monophyletic genus within the Characinae (Lucena 1987; Mirande 2010; Mattox and Toledo-Piza 2012; Menezes and Lucena 2014). The sister-group relationship between *Charax* and *Roebooides* was suggested by several authors (Lucena, 1998, 2000; Mirande, 2009, 2010; Mattox and Toledo-Piza 2012). However, Oliveira et al. (2011) alternatively suggested a different relationship between these two genera, proposing that *Charax* is the sister group of the clade comprising *Roebooides* Günther, 1864 and *Cynopotamus* Valenciennes, 1850. The presence of (1) a well-developed notch on the latero-ventral portion of cleithrum originating a relatively long posterior spiniform projection extending below pectoral-fin base and (2) an anterior shorter process oriented straight forward, or either inclined or bent laterally, was proposed by Lucena (1987) as the synapomorphy of the genus, a hypothesis corroborated by Mattox and Toledo-Piza (2012) and confirmed in the new species herein described (Fig. 5).

Charax awa sp.nov. possesses a relatively small eye or orbital diameter when compared to the other congeners, except *C. notulatus* and *C. caudimaculatus* (22.1–28.5 % HL; 26.1–28.5 % HL on specimens below 80 mm SL; and 22.1–25.4 % HL on specimens above 80 mm SL; see Tables 1 and 2). Despite the larger specimens of *C. awa* sp. nov. usually have a tendency to have smaller eye diameters when compared to the smaller specimens, the combined range of the eye diameter of these two size categories is even useful for the discrimination of the new species of all the congeners which possess a relatively larger eye diameter (29.6–38.4% HL combined). It is important to emphasize that the eye or orbital diameter is the main diagnostic character of *Charax* according to Menezes and Lucena (2014), which had used this character on their identification key to species of *Charax*, and as the first diagnostic feature in most of the species diagnoses. Other characters widely used by the last taxonomic revision of the genus were the lateral line, different types of scale counts, and the absence or presence or the number of teeth on the ectopterygoid. We confirmed here these characters as useful for species discrimination and taxonomy of the genus.

According to Menezes and Lucena (2014) a sexual dimorphism characterized by the presence of bony hooks on the anal and pelvic-fin rays of adult males is only recorded for *C. pauciradiatus*, *C. michaeli*, *C. gibbosus* and *C. niger* (in the case of the latter two, only in the anal-fin rays). Therefore, they concluded that the absence of these bony hooks is predominant across *Charax*. *Charax awa* sp. nov. apparently exhibits this general pattern of the genus, since bony hooks on these fins were not recorded in any of our examined material of the species, including 220 specimens over 84.0 mm SL. Thus, the species apparently does not possess an evident sexual dimorphism.

The river systems of northeastern Brazil, particularly the river basins of its occidental portion, including the region between the Rio Gurupi and Parnaíba basin, remain with their ichthyofauna poorly known and scarcely studied, despite recent efforts to sample and inventory this area (e.g. Soares, 2005, Barros et al. 2011, Ribeiro et al. 2014, Ramos et al. 2014, Matavelli et al. 2015, Melo et al. 2017, Piorski et al. 2017). The present study is an example of this state of knowledge. Further refined taxonomic studies will probably unveil more species and new taxa occurring in this area. Despite some freshwater fish species have been described occurring in this region and adjacent areas [e.g. *Corydoras julii* Steindachner, 1906, *Corydoras treitlii* Steindachner, 1906, *Knodus victorae* (Steindachner, 1907), *Otocinclus hasemani* Steindachner, 1915, *Hemiodus paraguayae* Eigenmann & Henn, 1916, *Corydoras vittatus* Nijssen, 1971, *Pterygoplichthys parnaíbae* (Weber, 1991), *Auchenipterus menezesi* Ferraris & Vari, 1999, *Roeboides margaretae* Lucena, 2003, *Geophagus parnaíbae* Staack & Schindler, 2006, *Roeboides sazimai* Lucena, 2007, *Platydoras brachylecis* Piorski, Garavello, Arce H. & Sabaj Pérez, 2008, *Cichlasoma zarskei* Ottoni, 2011, *Poecilia sarrafae* Bragança & Costa, 2011, *Hypsolebias coamazonicus* Costa, Amorim & Bragança, 2014, *Anablepsoides vieirai* Nielsen, 2016, *Parotocinclus cabessadecui* Ramos, Lima & Ramos, 2017 and *Hypostomus sertanejo* Zawadzki, Ramos & Sabaj Pérez, 2017]. Studies on range extension and new records of some freshwater fishes from the area between the mouth of Rio Gurupi and Delta do Rio Parnaíba (e.g. Barros et al. 2011, Matavelli et al. 2015, Guimarães et al. 2017a, 2017b, Lima et al. 2017), as well as the description of new species (cited above), suggest that the biogeographic history of the river basins of the region is complex and still poorly known. This region is an extremely ecologically relevant area since it comprises three of the main Brazilian biomes, as well as, transition zones between them: Amazônia, Brazilian Cerrado and Caatinga. Therefore, this area has faunal and floristic representatives of these three

biomes, which makes it extremely relevant in terms of ecology, biodiversity and conservation (Olson, et al., 2001; Piorski et al. 2008, Fiaschi and Pirani, 2009; Miranda et al., 2012).

Comparative material

Charax caudimaculatus: USNM 263877, 1, 95 mm SL, Laguna Cocococha, Reserva Nacional de Tambopata, Madre de Dios, **Peru**. (Radiograph of a Paratype). USNM 280291, 1, 95.0 mm SL, Laguna Cocococha, Reserva Nacional de Tambopata, Madre de Dios, **Peru**. (photograph of holotype).

Charax leticiae: all from **Brazil**: UFRJ: 1576, 4, 66.6-71.1, Goiás State, Aruanã municipality. CICCAA 00762, 2, 79.1-80.0 mm SL, Pará State, Parauapebas municipality. CPUFMA121858, 1, 81.0 mm SL, Maranhão state, stream at the Parque Estadual do Mirador (Rio Itapecuru basin), Mirador municipality.

Charax pauciradiatus: all from Maranhão State, **Brazil**. CICCAA00899, 3, 79.1-84.7. Maranhão State, Igarapé Papagaio, Tocantins river basin, São Pedro da Agua Branca Municipality. CPFUMA10860, 6, 88.6-117.46, Igarapé mão-de-onça, Gurupi river basin, Centro Novo Municipality. CPUFMA00868, 9, 103.7-117.94, Gurupi river basin, Centro Novo Municipality. CPUFMA10869, 7, 98.5-113.0, Gurupi river basin, Centro Novo Municipality. CPUFMA11870, 8, 93.9-112.6, Gurupi river basin, Centro Novo Municipality. CPUFMA11871, 3, 89.1-113.2, Gurupi river basin, Centro Novo Municipality.

Charax notulatus: USNM: 360305, 1 (photograph of holotype), 77 mm SL, Guarico State, Cano Falcon, **Venezuela**.

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Figure legends

Figure 1. *Charax awa*: (A) Holotype, CICCAA 00752, 101.33 mm SL; Brazil, Maranhão, Alto Alegre do Pindaré, Pindaré river drainage, Mearim river basin. (Photographed by Beldo Ferreira). (B) Live specimen, paratype, CICCA00898, 62.2 mm SL; Brazil, Maranhão, Miranda do Norte, stream at the Miranda do Norte, Mearim river basin. (Photographed by Erick Guimarães).

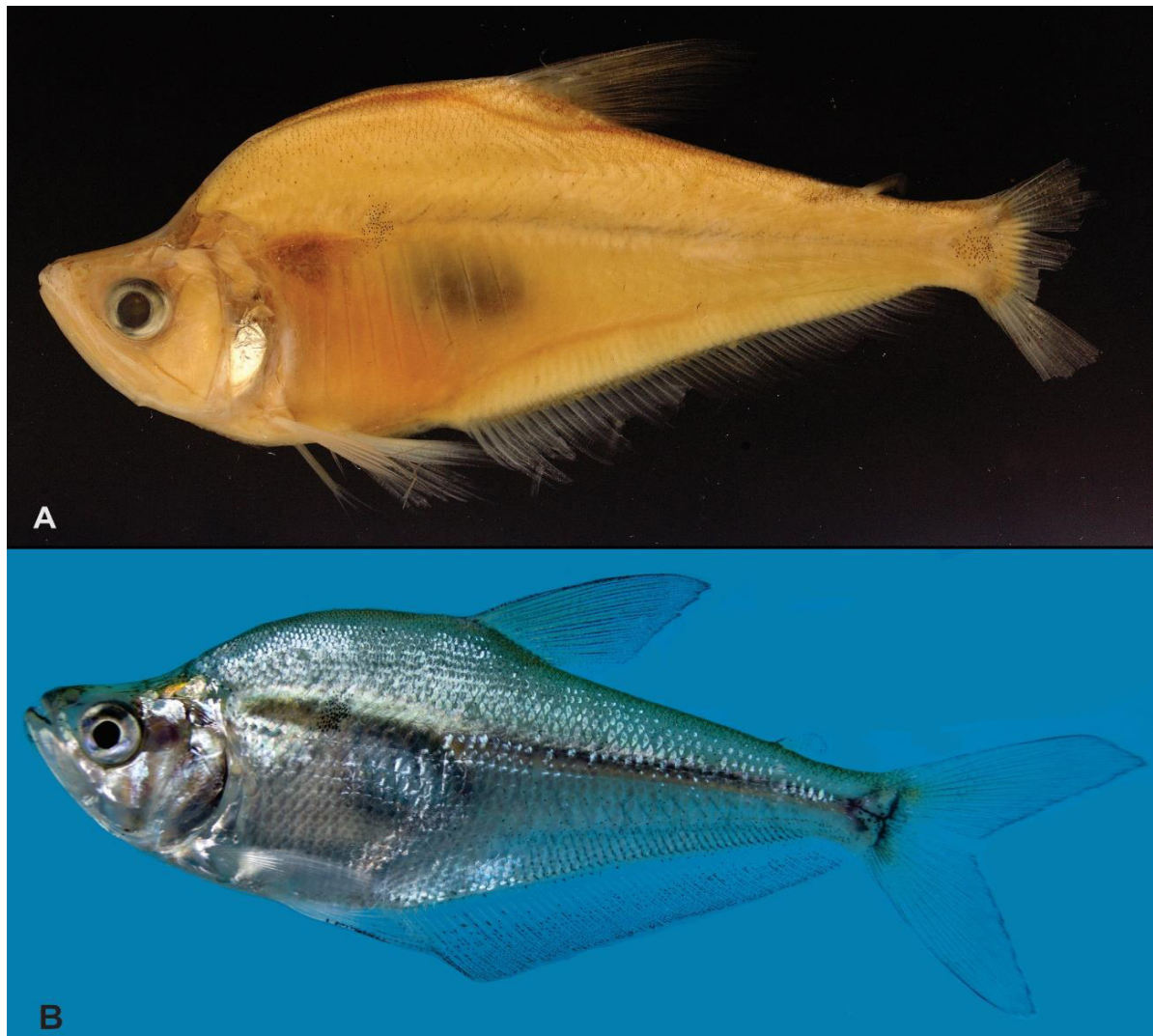


Figure 2. *Charax awa*, CICCAA00249, 73.8 mm SL; Jaws: (A) premaxilla, (B) maxilla and (C) lower jaw. Scale bar 1 mm. (Photographed by Erick Guimarães and Beldo Ferreira).

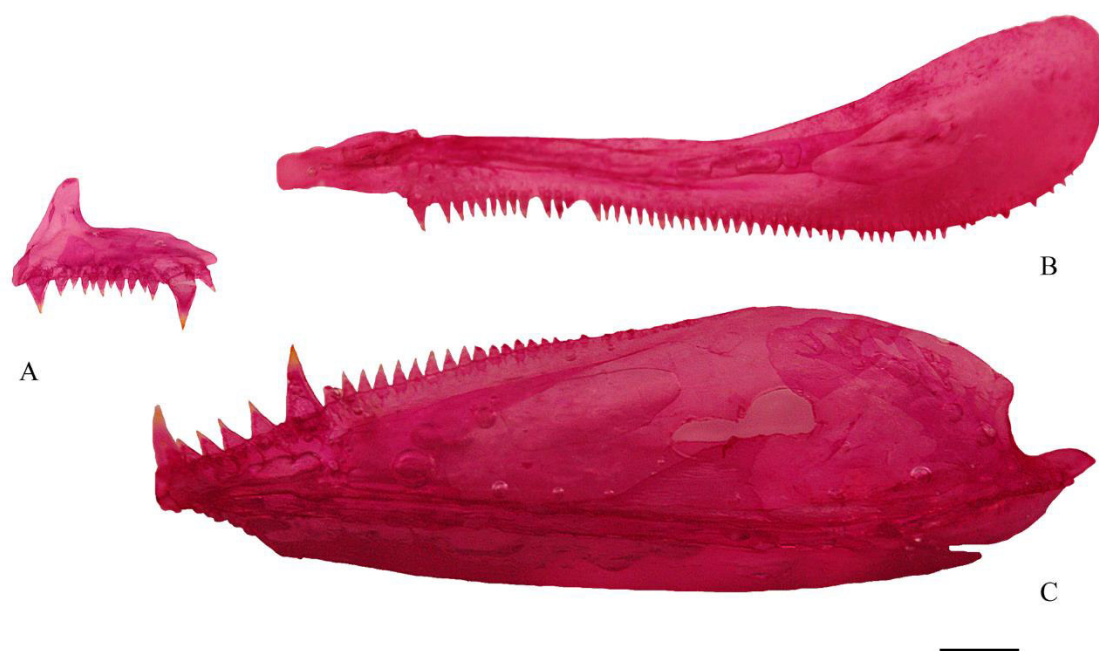


Figure 3. Distribution of *Charax awa* sp. nov. Paratypes (black circles) and holotype (red circle).

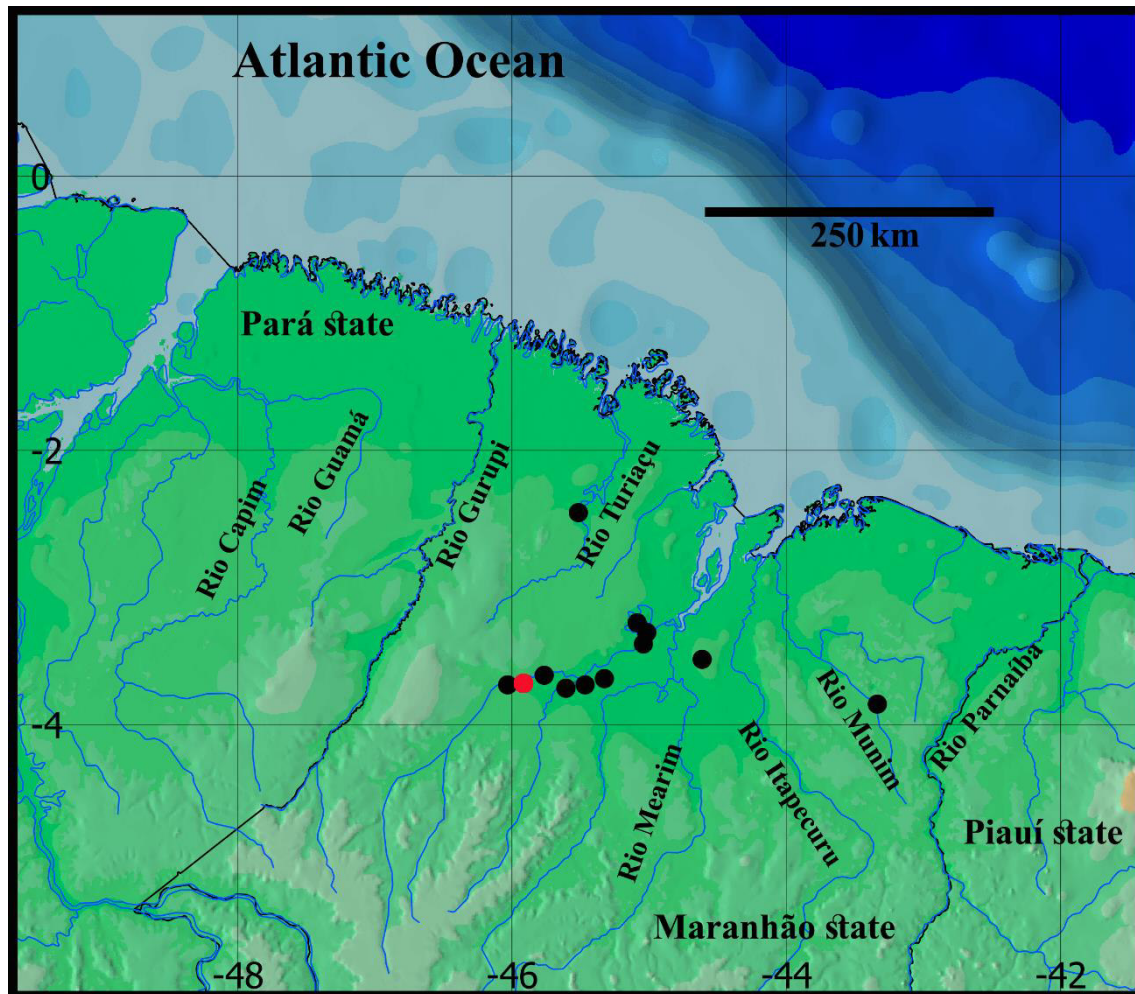


Figure 4. Distribution of *Charax awa* sp. nov, *C. leticiae*, *C. pauciradiatus* and *C. niger*. *Charax awa* sp. nov (red circle), *C. leticiae* (yellow circle), *C. pauciradiatus* (black circle) and *C. niger* (white circle). The type localities of the species are marked with an asterisk. Information of this map was based on our examined material and data provided by Menezes & Lucena (2014). See supplementary material.

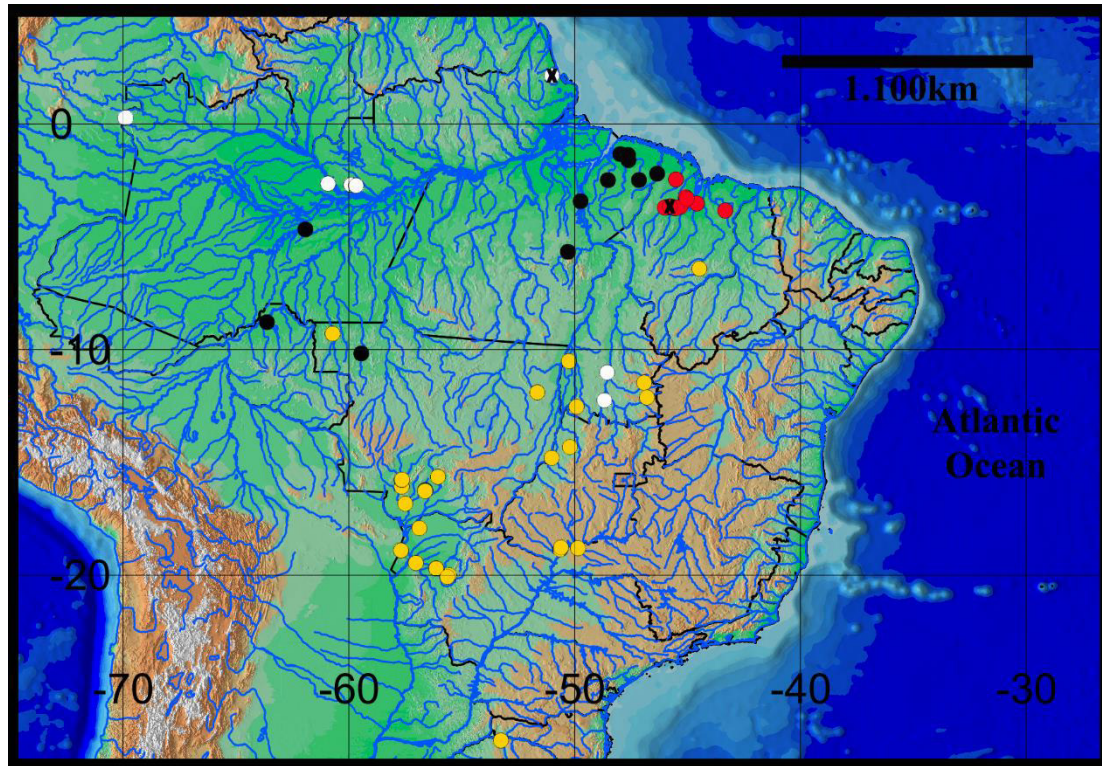


Figure 5. *Charax awa*, CICCAA00248, 73.8 mm SL; Pectoral girdle. Scale bar 1 mm.
(Photographed by Erick Guimarães and Beldo Ferreira).



Tabel legends

Table 1. Morphometric data of *Charax awa*.

Measurements	Holotype	N	Paratypes	Mean	SD
Standard length (SL)	101.3	107	40.2–120.0	88.4	-
Percentages of standard length					
Depth at dorsal-fin origin	40.0	106	27.7–42.5	37.8	2.8
Snout to dorsal-fin origin	55.0	106	46.5–57.9	52.4	1.5
Snout to pectoral-fin origin	28.4	104	22.8–37.0	28.5	1.8
Snout to pelvic-fin origin	35.5	105	28.6–48.3	37.1	1.8
Snout to anal-fin origin	51.9	103	42.4–65.4	50.3	3.6
Caudal peduncle depth	10.3	102	7.9–14.7	10.1	1.1
Caudal peduncle length	8.0	88	4.9–10.7	7.5	1.3
Pectoral-fin length	21.9	73	14.6–25.9	19.8	2.0
Pelvic-fin length	20.8	67	13.4–24.7	20.2	2.3
Dorsal-fin base length	12.7	101	8.7–15.2	11.0	1.1
Dorsal-fin height	29.9	64	21.8–49.6	28.7	3.6
Anal-fin base length	53.2	95	42.7–66.2	49.5	3.7
Eye to dorsal-fin origin	44.1	103	36.8–52.9	41.5	2.9
Dorsal-fin origin to caudal-fin base	54.8	101	46.3–69.5	53.9	3.0
Humeral spot distance	37.7	42	32.1–38.0	37.9	3.0
Bony head length	26.7	101	23.9–29.5	26.1	1.0
Percentages of head length					
Horizontal eye diameter	25.4	100	22.1–28.5	25.4	1.6
Snout length	27.2	100	23.2–35.1	26.9	2.4
Least interorbital width	26.2	101	18.9–31.1	25.0	2.2
Upper jaw length	70.6	100	52.1–75.5	62.8	3.9

Measurements	N	Paratypes	N	Paratypes
Standard length (SL)	33	40.2–79.2	74	81.6–120.0
Percentages of head length				
Horizontal eye diameter	29	26.1–28.5	71	22.1–25.4

Table 2. Morphometric data related to the horizontal eye diameter of *Charax awa* presented in separate classes of standard length.

APÊNDICE

APÊNDICE I: Artigo Publicado

Título: A new species of *Charax* (Ostariophysi, Characiformes, Characidae) from northeastern Brazil

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A new species of *Charax* (Ostariophysi, Characiformes, Characidae) from northeastern Brazil

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Abstract

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Key Words

Characinae

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Rio Turiaçu

taxonomy

Charax awa sp. n. is herein described from the Rio Mearim, Rio Munim and Rio Turiaçu basins, three coastal river basins of northeastern Brazil located between the Rios Gurupi and Parnaíba basins. These have a complex and still poorly known biogeographic history. This region is ecologically extremely relevant since it comprises three of the main Brazilian biomes, as well as, transition zones between them: Amazônia, Brazilian Cerrado and Caatinga. Therefore, this area has faunal and floristic representatives of these three biomes, which makes it particularly relevant in terms of ecology, biodiversity and conservation. *Charax awa* sp. n. possesses a relatively small orbital diameter (22.1–28.5 % HL), what distinguishes it from most of its congeners, except from *C. notulatus* and *C. caudimaculatus*. It differs from *C. caudimaculatus* by a longer snout, and from *C. notulatus* by the number of scales around the caudal peduncle, as well as by the number of vertebrae. The new species herein described differs from its geographically closely distributed congeners, *C. leticiae*, *C. niger*, and *C. pauciradiatus* mainly by the relative horizontal orbital diameter. It is a “small-eyed” species. In addition, *C. awa* sp. n. can be distinguished from *C. leticiae* by having a maxilla extending to the vertical line posterior to the pupil, near the posterior orbital margin and by having a lower humeral spot distance. It can be distinguished from *C. pauciradiatus* by more scale rows from the pelvic-fin origin to the lateral line and more scale rows from the dorsal-fin origin to the lateral line and it differs from *C. niger* by having more transverse scale rows in space from the humeral spot to the supracleithrum. In addition, it differs from *C. pauciradiatus* and *C. niger* by the absence of bony hooks on anal and pelvic-fins rays of adult males.

Introduction

Characidae is the most species-rich family of Characiformes, comprising about 165 genera and more than 1.150 species, distributed along the river systems between southwestern Texas and Mexico in North America and Patagonia in South America (Nelson et al. 2016; Eschmeyer et al.

2017). *Charax* Scopoli, 1777 is a South American characid genus possessing a midsized (maximum size about 130.0 mm SL) and deep body, being the type genus of the Characidae, comprising 16 valid species (Menezes and Lucena 2014), widely distributed in the Cis-Andean region, occurring in the Amazonas, Paraná, Uruguay, Paraguay, Capim, and Orinoco river basins, as well as in

smaller isolated river basins draining the Guiana Shield, and in the Lagoa dos Patos system, and other coastal lagoons of southern Brazil (Menezes and Lucena 2014).

The distribution of the genus is mainly concentrated in central and northern South America; there is no record for eastern Brazil and none of the valid species was assigned for the coastal river basins of northeastern Brazil by the recent taxonomic revision of the genus (see Menezes and Lucena 2014). However, some records of *Charax* for the coastal river basins of northeastern Brazil were made before the taxonomic revision made by Menezes and Lucena (2014): Martins and Oliveira (2011) recorded *C. gibbosus* for the Rio Mearim basin; Barros et al. (2011) recorded *Charax* sp. for the Rio Itapecuru basin; Martins and Oliveira (2011) recorded *Charax* sp. for the Rio Pericumã basin and Rio Mearim basin.

Charax can be distinguished from all other characid genera by the presence of a deep concavity on the latero-ventral portion of the cleithrum originating a relatively long posterior spiniform projection extending below pectoral-fin base; and an anterior shorter process oriented straight forward or either inclined or bent laterally (Lucena 1987, Mattox and Toledo-Piza 2012: fig 34, Menezes and Lucena 2014). A new species of *Charax* is herein described from the Rio Mearim, Rio Munim and Rio Turiaçu basins, three coastal river basins of northeastern Brazil.

Material and methods

Counts and measurements were taken according to Fink and Weitzman (1974), Menezes and Weitzman (1990) and Menezes and Lucena (2014), on the left side of specimens whenever possible, using a digital caliper with precision of 0.01 mm. Measurements are given as a percentage of standard length (SL), except for subunits of the head, which are given as a percentage of head length (HL). Vertebrae of the Weberian apparatus were not included in the vertebral counts, whereas the fused PU1+U1 of the caudal region was counted as a single element. Counts for supraneurals, vertebrae, rib pairs, branchiostegal rays, gill-rakers, premaxillary, maxillary, and dentary teeth, procurent caudal-fin rays, and pterygiophores were taken only from cleared and stained paratypes (C&S), prepared according to Taylor and Van Dyke (1985); number of examined specimens are in parentheses. Osteological nomenclature follows Weitzman (1962). Diagnosis was made based on a unique combination of character states, according to Davis and Nixon (1992). Information about congeners was based on both comparative material and literature (e.g. Lucena 1987, Mattox and Toledo-Piza 2012, Menezes and Lucena 2014). Institutional abbreviations are: **CICCAA** Coleção Ictiológica do Centro de Ciências Agrárias Ambientais, Universidade Federal do Maranhão, Chapadinha; **CPUFMA** Coleção de Peixes da Universidade Federal do Maranhão, São Luis; **UFRJ** Coleção Ictiológica do Instituto de Biologia, Universidade Federal do Rio de Janeiro, Rio de Janeiro; **MCP**

Museu de Ciências e Tecnologia, Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre; **USNM** Smithsonian Institution National Museum of Natural History, Washington D.C., U.S.A.; **CM** Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, U.S.A.; and **MHNM** Museo Nacional de Historia Natural y Antropología, Zoología, Sección Ictiología, Ministerio de Educación y Cultura, Montevideo, Uruguay.

Results

Charax awa sp. n.

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Fig. 1

Charax gibbosus [non *Charax gibbosus* (Linnaeus, 1758)]: Martins and Oliveira 2011: 196–197.

Charax sp. - Martins and Oliveira 2011:196–197.

Holotype. CICCAA 00752, 101.3 mm SL, Brazil: Maranhão State: Alto Alegre do Pindaré municipality: Igarapé Mineirão, Rio Mearim basin, 3°42'26"S, 45°56'5"W; Guimarães E. C. and Costa C.H.; 03 Dec. 2015.

Paratypes. All from Maranhão State, Brazil: CICCAA 00248, 9, 47.7–90.6 mm SL; CICCAA 00249, 6 (C&S), 42.6–73.8 mm SL; CICCAA 00754, 2, 55.2–68.7 mm SL; collected with holotype. CICCAA 00753, 1 (C&S), 41.4 mm SL, Rio Zutua (Rio Mearim basin), Santa Inês municipality, 3°43'48"S, 45°35'7"W; Guimarães E. C. and Costa C.H.; 03 Dec 2015. CICCAA 00766, 1 (C&S), 78.5 mm SL, Rio Zutua (Rio Mearim basin), Santa Inês municipality, 3°43'48"S, 45°35'7"W; Guimarães E. C. and Costa C.H.; 03 Dec 2015. CICCAA 00755, 1, 59.8 mm SL; stream at the Santa Inês municipality (Rio Mearim basin), Santa Inês municipality, 3°40'48"S, 45°19'51"W; Guimarães E. C. and Costa C.H.; 03 Dec 2015. CICCAA 00896, 2, 40.2–48.8 mm SL stream Arapapá (Rio Mearim basin), Alto Alegre municipality; 3°42'30"S, 46°0'19"W; Guimarães E. C. and Brito P. S.; 15 Ago 2017. CICCAA 00765, 11, 44.4–68.3 mm SL Lirio stream (Rio Mearim basin), Alto Alegre municipality; 3°38'56"S, 45°46'18"W; Guimarães E. C. and Brito P.S.; 15 Ago 2017. CICCAA 00764, 5, 68.4–89.3 mm SL, Olho d'água dos Carneiros (Rio Mearim basin), Santa Inês municipality; 3°43'0"S, 45°28'36"W; Guimarães E. C. and Brito P.S.; 11 Ago 2017. CICCAA 00898, 1, 62.2 mm SL, stream at Miranda do Norte municipality (Rio Mearim basin), 3°31'30"S, 44°35'6"W; Guimarães E. C. and Brito P.S.; 13 Ago 2017.

UFRJ 11696, 2, 69.9–70.6 mm SL stream Arapapá (Rio Mearim basin), Alto Alegre municipality; 3°42'30"S, 46°0'19"W; Guimarães E. C. and Brito P.S.; 15 Ago 2017. MCP 52700, 4, 45.9–75.1 mm SL Arapapá stream (Rio Mearim basin), Alto Alegre municipality; 3°42'30"S, 46°0'19"W; Guimarães E. C. and Brito P.S.; 15 Ago 2017. CUFMA 98859, 40, 52.2–120.0 mm SL, Rio Turiaçu, (Rio Turiaçu basin), Santa Helena municipality;

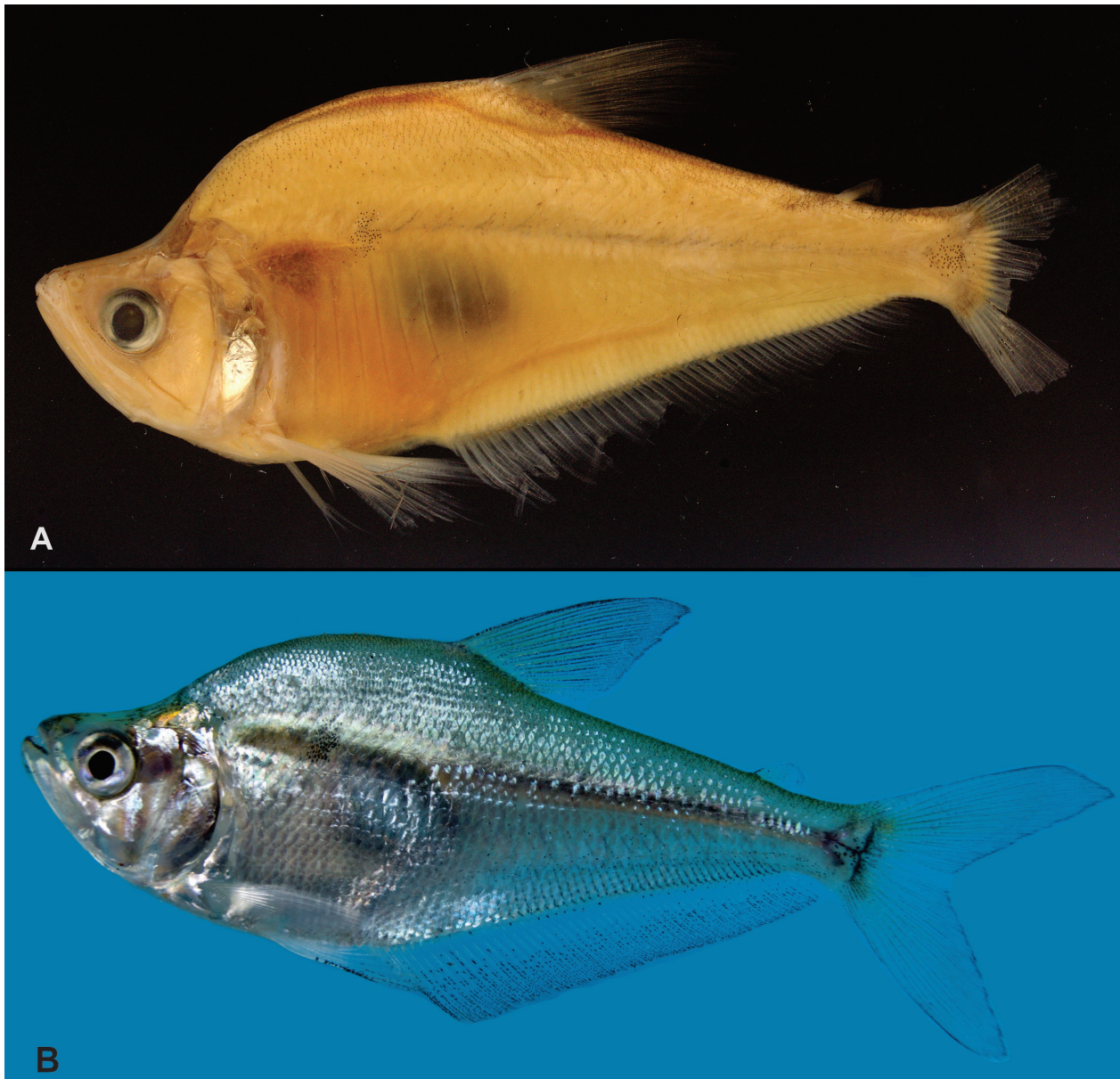


Figure 1. *Charax awa*: (A) Holotype, CICCAA 00752, 101.33 mm SL; Brazil, Maranhão, Alto Alegre do Pindaré, Pindaré river drainage, Mearim river basin. (Photographed by Beldo Ferreira). (B) Live specimen, paratype, CICCAA00898, 62.2 mm SL; Brazil, Maranhão, Miranda do Norte, stream at the Miranda do Norte, Mearim river basin. (Photographed by Erick Guimarães).

2°27'35"S, 45°30'42"W; Piorski et al. 8 Ago 1998. CPUFMA 001747, 18, 76.9–117.3 mm SL, Rio Turiaçu, (Rio Turiaçu basin), Santa Helena municipality; 2°27'35"S, 45°30'42"W; Piorski et al. 17 Abr 2000. CPUFMA 112036, 4, 88.5–88.7 mm SL, Rio Munim, Chapadinha municipality; 3°50'19"S, 43°19'46"W; Nunes et al. 8 Jul 2011. CPUFMA 98136, 3, 85.2–93.7 mm SL, Lago de Viana (Rio Mearim basin), Cajari municipality; 3°22'48"S, 45°2'57"W; Piorski and Pereira, 17 Mar 1998. CPUFMA 98135, 3, 85.6–91.4 mm SL, Lago de Viana (Rio Mearim basin), Cajari municipality; 3°18'54"S, 45°1'40"W; Piorski and Pereira, 17 Mar 1998. CPUFMA 98137, 1, 88.2 mm SL, Lago de Viana (Rio Mearim basin), Viana municipality; 3°15'9"S, 45°4'48"W; Piorski and Pereira, 14 Mar 1998. CPUFMA 97130, 1, 91.3 mm SL, stream Enge-

nho (Rio Mearim basin), Viana municipality; 3°12'26"S, 44°58'5"W; Piorski and Pereira, 6 Dez 1997.

Non type material. All from Maranhão State, Brazil: CPUFMA 98861, 24, 83.5–120.0 mm SL, Rio Turiaçu, (Rio Turiaçu basin), Santa Helena municipality; 2°27'35"S, 45°30'42"W; Piorski et al. 8 Ago 1998. CPUFMA 98862, 23, 79.4–119.1 mm SL, Rio Turiaçu, (Rio Turiaçu basin), Santa Helena municipality; 2°27'35"S, 45°30'42"W; Piorski et al. 14 Ago 1998. CPUFMA 00863, 25, 68.0–113.1 mm SL, Rio Turiaçu, (Rio Turiaçu basin), Santa Helena municipality; 2°27'35"S, 45°30'42"W; Piorski et al. 21 Ago 2000. CPUFMA 00864, 43, 72.3–113.9 mm SL, Rio Turiaçu, (Rio Turiaçu basin), Santa Helena municipality; 2°27'35"S, 45°30'42"W; Piorski

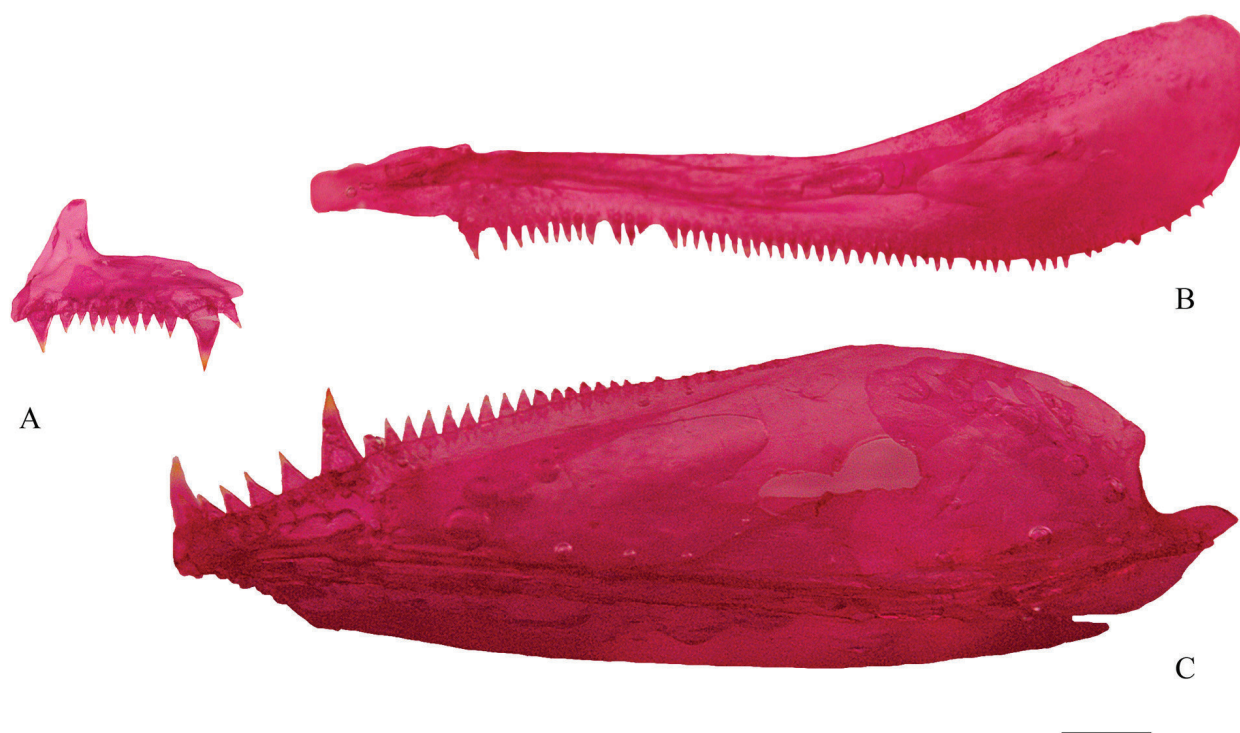


Figure 2. *Charax awa*, CICC00249, 73.8 mm SL; Jaws: (A) premaxilla, (B) maxilla and (C) lower jaw. Scale bar 1 mm. (Photographed by Erick Guimarães and Beldo Ferreira).

et al. 16 Out 2000. CPUFMA 00865, 11, 82.3–114.2 mm SL, Rio Turiaçu, (Rio Turiaçu basin), Santa Helena municipality; 2°27'35"S, 45°30'42"W; Piorski et al. 21 Ago 2000. CPUFMA 00866, 31, 82.6–110.3 mm SL, Rio Turiaçu, (Rio Turiaçu basin), Santa Helena municipality; 2°27'35"S, 45°30'42"W; Piorski et al. 15 Out 2000. CPUFMA 00867, 16, 88.7–102.12 mm SL, Rio Turiaçu, (Rio Turiaçu basin), Santa Helena municipality; 2°27'35"S, 45°30'42"W; Piorski et al. 22 Jun 2000.

Diagnosis. *Charax awa* sp. n. can be distinguished from *C. apurensis* Lucena, 1987, *C. condei* (Géry & Knöppel, 1976), *C. delimai* Menezes & Lucena, 2014, *C. gibbosus* (Linnaeus, 1758), *C. hemigrammus* (Eigenmann, 1912), *C. leticiae* Lucena, 1987, *C. macrolepis* (Kner, 1858), *C. metae* Eigenmann, 1922, *C. michaeli* Lucena, 1989, *C. niger* Lucena, 1989, *C. pauciradiatus* (Günther, 1864), *C. stenopterus* (Cope, 1894) *C. tectifer* (Cope, 1870) by the orbital diameter (22.1–28.5% HL vs. 29.6–38.4% HL combined) (Fig. 2). *Charax awa* sp. n. differs from *C. caudimaculatus* Lucena, 1987 by the possession of a longer snout (snout length 23.3–32.8% HL vs. 20.3–22.8% HL); from *C. notulatus* Lucena, 1987 by the number of scales around the caudal peduncle (15–18 vs. 20–22) and by having more vertebrae (35 vs. 32). Furthermore, *Charax awa* sp. n. can be distinguished from *C. condei*, *C. hemigrammus* and *C. stenopterus* by having the lateral line complete (vs. incomplete); from *C. delimai*, *C. metae* and *C. tectifer* by having a toothless ectopterygoid (vs. presence of teeth on ectopterygoid) and having the anal-fin origin always anterior to the vertical through the dorsal-fin origin (vs. anal-fin origin on,

or slightly posterior to the vertical through the dorsal-fin origin); from *C. condei*, *C. delimai*, *C. hemigrammus*, *C. metae*, *C. pauciradiatus* and *C. stenopterus* by the number of scale rows from the pelvic-fin origin to the lateral line (11–12 vs. 6–10 combined); from *C. pauciradiatus* by having more scale rows from the dorsal-fin origin to the lateral line (15–18 vs. 13–14). It can be distinguished from *C. niger* by having 8–10 transverse scale rows in space from the humeral spot to the supracleithrum (vs. 5–6); from *C. condei*, *C. delimai*, *C. metae*, *C. rupununi* Eigenmann, 1912 by the number of scale rows around the caudal peduncle (15–18 in *C. awa* sp. n. vs. 12–14 combined in *C. condei* and *C. rupununi*, 19–21 combined in *C. delimai* and *C. metae*). Finally, it differs from *C. leticiae* by having the maxilla extending to a vertical line posterior to pupil, near the posterior orbital margin (vs. maxilla extending slightly beyond vertical through middle of pupil) and from humeral spot distance (35.8–38.0 % SL vs. 39.0–44.0 % SL).

Description. Morphometric data are presented in Tables 1 and 2. Body moderately large (40.2–120.0 mm SL), compressed and moderately deep; greatest body depth slightly in advance of dorsal-fin origin. Dorsal profile of head and body slightly convex on tip of snout, approximately straight from posterior border of posterior nostril to vertical line through posterior border of pupil, concave from that point to about half of distance between pupils and posterior margins of preopercle, strongly convex from that point to dorsal-fin origin, nearly straight along dorsal-fin base and from end of dorsal-fin base to caudal peduncle and slightly concave along caudal peduncle. Ventral pro-

Table 1. Morphometric data of *Charax awa*.

Measurements	Holotype	N	Paratypes	Mean	SD
Standard length (SL)	101.3	107	40.2–120.0	88.4	–
Percentages of standard length					
Depth at dorsal-fin origin	40.0	106	27.7–42.5	37.8	2.8
Snout to dorsal-fin origin	55.0	106	46.5–57.9	52.4	1.5
Snout to pectoral-fin origin	28.4	104	22.8–37.0	28.5	1.8
Snout to pelvic-fin origin	35.5	105	28.6–48.3	37.1	1.8
Snout to anal-fin origin	51.9	103	42.4–65.4	50.3	3.6
Caudal peduncle depth	10.3	102	7.9–14.7	10.1	1.1
Caudal peduncle length	8.0	88	4.9–10.7	7.5	1.3
Pectoral-fin length	21.9	73	14.6–25.9	19.8	2.0
Pelvic-fin length	20.8	67	13.4–24.7	20.2	2.3
Dorsal-fin base length	12.7	101	8.7–15.2	11.0	1.1
Dorsal-fin height	29.9	64	21.8–49.6	28.7	3.6
Anal-fin base length	53.2	95	42.7–66.2	49.5	3.7
Eye to dorsal-fin origin	44.1	103	36.8–52.9	41.5	2.9
Dorsal-fin origin to caudal-fin base	54.8	101	46.3–69.5	53.9	3.0
Humeral spot distance	37.7	42	32.1–38.0	37.9	3.0
Bony head length	26.7	101	23.9–29.5	26.1	1.0
Percentages of head length					
Horizontal eye diameter	25.4	100	22.1–28.5	25.4	1.6
Snout length	27.2	100	23.2–35.1	26.9	2.4
Least interorbital width	26.2	101	18.9–31.1	25.0	2.2
Upper jaw length	70.6	100	52.1–75.5	62.8	3.9

Table 2. Morphometric data related to the horizontal eye diameter of *Charax awa* presented in separate classes of standard length.

Measurements	N	Paratypes	N	Paratypes
Standard length (SL)	33	40.2–79.2	74	81.6–120.0
Percentages of head length				
Horizontal eye diameter	29	26.1–28.5	71	22.1–25.4

file of head and trunk convex from tip of lower jaw to anal-fin origin, nearly straight along anal-fin base and slightly concave from end of anal-fin base to beginning of procurvent rays. Snout pointed. Lower jaw included in upper jaw when mouth closed. Maxilla extending to a vertical line posterior to pupil, near the posterior orbital margin. Small triangular posteriorly directed projection at intersection between dorsal and posterior margins of hyomandibular (Mattox and Toledo-Piza 2012: figs 24A, 25B).

Dorsal-fin rays ii, 9 (72). Dorsal-fin pterygiophores 10 (8); first dorsal-fin pterygiophore between 4th and 5th vertebrae. Adipose fin present. Unbranched anal-fin rays iv (74) or v (1), branched rays 46 (4), 47 (5), 48 (10), 49 (13), 50 (9), 51 (6), 52 (13), 53 (5), 54 (2) or 56 (1). Anal-fin pterygiophores 46 (2), 47 (2), 48 (1), 49 (2) or 50 (1); first anal-fin pterygiophore between 7th and 8th vertebrae. Pectoral-fin rays i, 13 (3) or 14 (22). Tips of longest pectoral-fin rays reaching slightly beyond middle of pelvic-fin length. Pelvic-fin rays i, 7 (64) or i, 8 (2). Axilar scale on pelvic fin absent. Tips of longest pelvic-fin rays reaching anal-fin rays, between bases of second to seventh branches. Principal caudal-fin ray count 10/9 (59). Dorsal procurvent caudal-fin rays 12 (1), 14 (2), 15(1),

16 (2) or 17 (2). Ventral procurvent caudal-fin rays 7 (3), 8 (2), 9 (1), 1 (10) or 11 (1).

Ventral-most longitudinal series of scales on each side of trunk overlapping one another, delimiting longitudinal gap on region anterior to anus. Scale sheath along anal-fin base. Scales on caudal fin restricted to base of rays. Lateral line complete; perforated scales 53 (1), 54 (3), 55 (8), 56 (10), 57 (4), 58 (2), 59 (4), 60 (7), 61 (4), 62(3) or 63 (1). Horizontal scale rows between dorsal-fin origin and lateral line 15 (27), 16 (20), 17 (5) or 18 (3). Horizontal scale rows between pelvic-fin origin and lateral line 11 (66) or 12 (4). Horizontal scale rows between anal-fin origin and lateral line 12 (2), 13 (37), 14 (16), 15 (7) or 16 (1). Scale rows around caudal peduncle 15 (4), 16 (26), 17 (13) or 18 (3). Scale row along anal-fin base, extending for about two thirds of fin base. Predorsal scales 49 (1), 50 (6), 52 (9), 53 (5), 54(7), 55(3), 56(3), 57 (1), 58 (1), 59 (1), 60 (1), 62 (4), 63 (2), 64 (1), 66 (1), 68 (2). Transverse scale rows between humeral spot and supracleithrum 8 (57), 9 (16) or 10 (1).

Premaxilla and dentary with two canine-like teeth and remaining teeth conical. Maxilla with all teeth conical. Premaxilla with one anterior canine-like tooth followed by set of smaller conical teeth, another canine-like tooth placed on posterior portion of bone, followed by one or two small conical teeth (Fig. 2). Total number of premaxillary teeth 13 (4), 14 (3) or 15 (1). Maxilla with 52 (1), 55 (4), 58 (2) or 60 (1) teeth. Dentary with one canine-like tooth followed by 3–4 conical teeth, another canine-like tooth followed by a posterior row of 16 (3), 18 (4) or 19 (1) conical teeth (Fig. 2).

Ectopterygoid and metapterygoid without teeth. Gill-rakers on lower limb of first gill-arch 13 (2), 14 (3). Branchiostegal rays 3 (1) or 4 (7). Supraneurals 4 (8); first supraneural inserted posterior to neural spine of 4th centrum, and last supraneural inserted anterior to first dorsal-fin pterygiophore. Precaudal vertebrae 12 (8). Caudal vertebrae 23 (8). Total vertebrae 35 (8). Pleural rib pairs 11 (8). Pre- and postzygapophyses minute, approximately triangular in shape, and positioned somewhat parallel to neural zygapophysis of adjacent vertebra (e.g. Mattox and Toledo-Piza 2012: fig. 32A).

Color in alcohol (Fig. 1A). Body pale yellow to light yellow, slightly darker dorsally. Both extreme dorsal and ventral regions of trunk with scattered dark chromatophores. Inconspicuous approximately rounded or slightly elliptical dark brown humeral blotch, extending about three to four scales horizontally and about five vertically. Dorsal part of head, snout, circumorbital region and opercle darker than rest of head. Scattered dark chromatophores on tip of snout and suborbital region. V-shaped lines of chromatophores over myosepta along epaxial and hypaxial muscles, more visible on mid-posterior portion of body. Inconspicuous, approximately triangular shaped dark blotch on caudal-fin base, with posterior dark chromatophores. Inconspicuous clear stripe at anal-fin base. All fins hyaline, or light brown at base, with scattered dark chromatophores more visible on interradiial membranes.

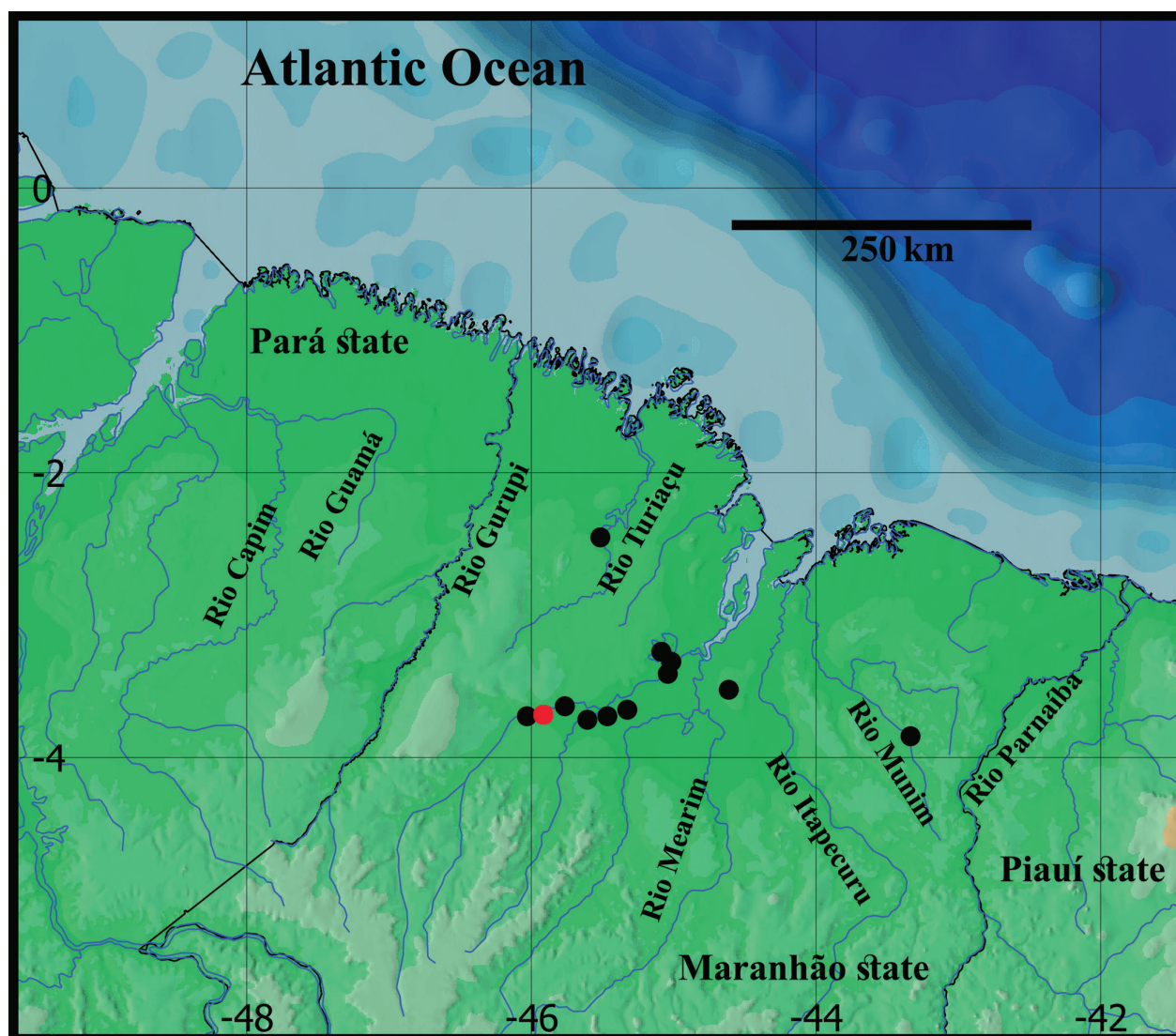


Figure 3. Distribution of *Charax awa* sp. n. Paratypes (black circles) and holotype (red circle).

Anterior portion of first to third unbranched rays of dorsal and first unbranched rays of pectoral and pelvic-fin rays darker than remaining rays.

Color in life (Fig. 1B). Color pattern in life similar to coloration of preserved specimens. Body silver on, anterior portion, and silver to hyaline on posterior portion. Anterior and dorsal portions of trunk darker, and sides of head darker than rest of body. Humeral and caudal-fin base blotches inconspicuous. Dorsal margin of trunk with conspicuous dark brown chromatophores. Purple longitudinal stripe along mid-portion of flank, extending posteriorly to anterior margin of caudal-fin base. Fins hyaline, with scattered dark brown or black chromatophores, more visible on interradial membranes.

Sexual dimorphism. No apparent sexual dimorphism.

Distribution. *Charax awa* is known from the Rio Mearim, Rio Munim and Rio Turiaçu basins, Maranhão state, northeastern Brazil (Fig. 3).

Remarks. The new species herein described differs from its geographically closely distributed congeners, *C. leticiae*, *C. niger*, and *C. pauciradiatus*, with records in the Lower Amazon, Capim, upper Itapecuru and Tocantins river basins (Fig. 4), mainly by the horizontal orbital diameter (see diagnosis section). In addition, *C. awa* sp. n. can be distinguished from *C. leticiae* by having the maxilla extending to a vertical line posterior to pupil, near posterior orbital margin while *C. leticiae* shows the maxilla extending slightly beyond vertical through middle of pupil and by humeral spot distance (32.1–38.0 % SL vs. 39.0–44.0 % SL). It can be distinguished from *C. pauciradiatus* by possessing 11–12 scale rows from the pelvic-fin origin to the lateral line and 15–18 scale rows from the dorsal-fin origin to the lateral line, while *C. pauciradiatus* possess 6–10 and 13–14, respectively, and differs from *C. niger* by having 8–10 transverse scale rows in space from the humeral spot to the supracleithrum, while *C. niger* possess 5–6. Moreover, it differs from *C. pauciradiatus* and *C. niger* by the absence of bony hooks on anal and pelvic-fins rays of adult males. This last character is emphasized in the discussion section.

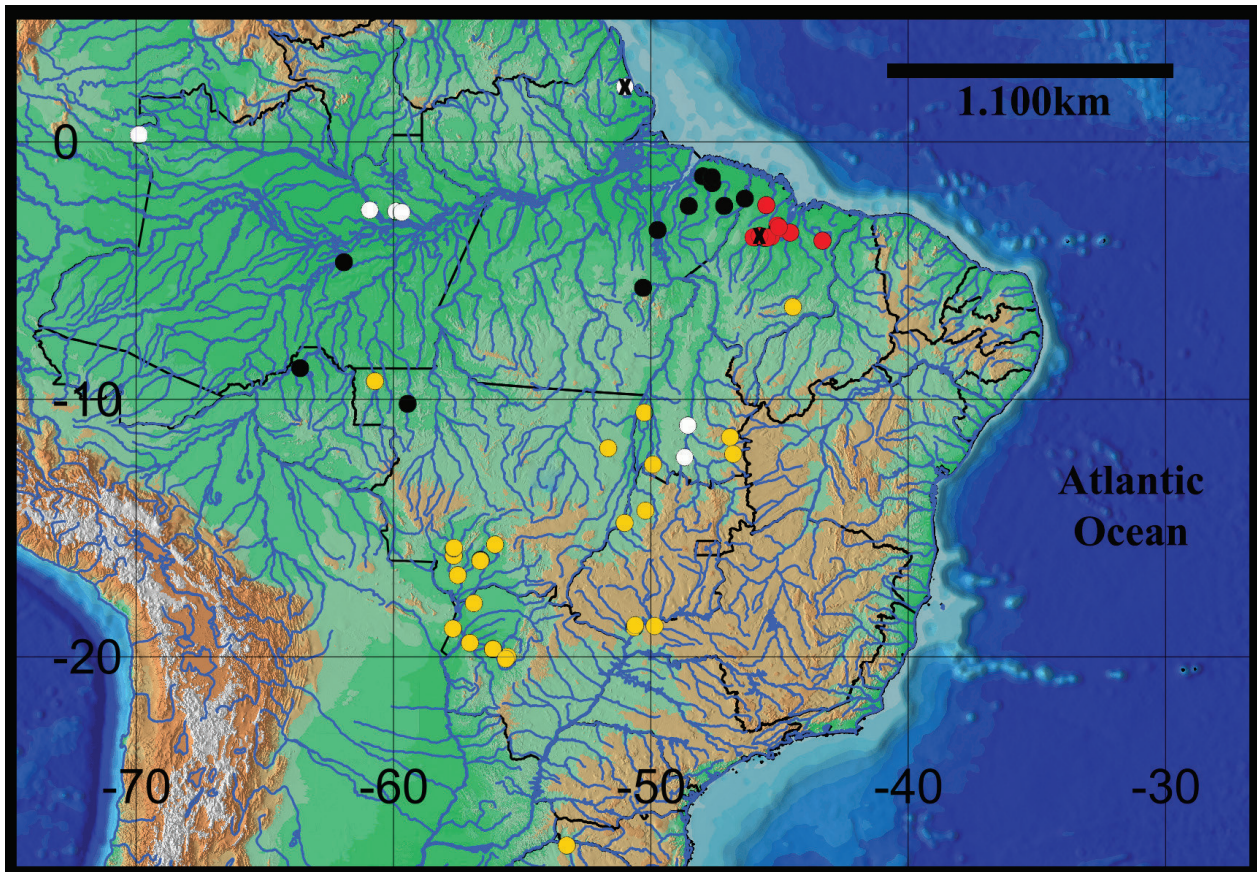


Figure 4. Distribution of *Charax awa* sp. n., *C. leticiae*, *C. pauciradiatus* and *C. niger*. *Charax awa* sp. n. (red circle), *C. leticiae* (yellow circle), *C. pauciradiatus* (black circle) and *C. niger* (white circle). The type localities of the species are marked with an asterisk. Information of this map was based on our examined material and data provided by Lucena 1987, and Menezes and Lucena 2014. See Suppl. material 1.

In addition, new species herein described differs from *C. gibbosus*, a species incorrectly identified for the same area of *C. awa* sp. n. by the following features:

Charax awa sp. n. possesses a toothless ectopterygoid, absence of bony hooks on anal-fin rays of mature males, 8–10 transverse scales rows between the humeral spot and the suprecleithrum and 49–68 predorsal scales; while *C. gibbosus* has teeth on ectopterygoid, bony hooks on anal-fin rays of mature males, 5–6 transverse scales rows between the humeral spot and the suprecleithrum, and 38–45 predorsal scales.

Etymology. The specific epithet honors the term *Awá*, from Tupi-guarani, meaning “man, people, person”, used by the native tribe Guajá, from the Maranhão state, for their self-denomination.

Discussion

Several authors have pointed out that *Charax* constitutes a monophyletic genus within the Characinae (Lucena 1987; Miranda 2010; Mattox and Toledo-Piza 2012; Menezes and Lucena 2014). The sister-group relationship between *Charax* and *Roeboides* was suggested by several authors

(Lucena 1998, 2000; Miranda 2009, 2010; Mattox and Toledo-Piza 2012). However, Oliveira et al. (2011) alternatively suggested a different relationship between these two genera, proposing that *Charax* is the sister group of the clade comprising *Roeboides* Günther, 1864 and *Cynopotamus* Valenciennes, 1850. The presence of (1) a well-developed notch on the latero-ventral portion of cleithrum originating a relatively long posterior spiniform projection extending below pectoral-fin base and (2) an anterior shorter process oriented straight forward, or either inclined or bent laterally, was proposed by Lucena (1987) as the synapomorphies of the genus, a hypothesis corroborated by Mattox and Toledo-Piza (2012) and confirmed in the new species herein described (Fig. 5).

Charax awa sp. n. possesses a relatively small eye or orbital diameter when compared to the other congeners, except *C. notulatus* and *C. caudimaculatus* (22.1–28.5 % HL; 26.1–28.5 % HL on specimens below 80 mm SL; and 22.1–25.4 % HL on specimens above 80 mm SL; see Tables 1 and 2). Despite the larger specimens of *C. awa* sp. n. usually have a tendency to have smaller eye diameters when compared to the smaller specimens, the combined range of the eye diameter of these two size categories is even useful for the discrimination of the new species of all the congeners which possess a relatively larger eye diameter (29.6–



Figure 5. *Charax awa*, CICCAA00248, 73.8 mm SL; Pectoral girdle. Scale bar 1 mm. (Photographed by Erick Guimarães and Beldo Ferreira).

38.4 % HL combined). It is important to emphasize that the eye or orbital diameter is the main diagnostic character of *Charax* according to Menezes and Lucena (2014), which had used this character on their identification key to species of *Charax*, and as the first diagnostic feature in most of the species diagnoses. Other characters widely used by the last taxonomic revision of the genus were the lateral line, different types of scale counts, and the absence or presence or the number of teeth on the ectopterygoid. We confirmed here these characters as useful for species discrimination and taxonomy of the genus.

According to Menezes and Lucena (2014) a sexual dimorphism characterized by the presence of bony hooks on the anal and pelvic-fin rays of adult males is only recorded for *C. pauciradiatus*, *C. michaeli*, *C. gibbosus* and *C. niger* (in the case of the latter two, only in the anal-fin rays). Therefore, they concluded that the absence of these bony hooks is predominant across *Charax*. *Charax awa* sp. n. apparently exhibits this general pattern of the genus, since bony hooks on these fins were not recorded in any of our examined material of the species, including 220 specimens over 84.0 mm SL. Thus, the species apparently does not possess an evident sexual dimorphism.

The river systems of northeastern Brazil, particularly the river basins of its occidental portion, including the region between the Rio Gurupi and Parnaíba basin, remain

with their ichthyofauna poorly known and scarcely studied, despite recent efforts to sample and inventory this area (e.g. Soares 2005, Barros et al. 2011, Ribeiro et al. 2014, Ramos et al. 2014, Matavelli et al. 2015, Melo et al. 2017, Piorski et al. 2017). The present study is an example of this state of knowledge. Further refined taxonomic studies will probably unveil more species and new taxa occurring in this area. Despite some freshwater fish species have been described occurring in this region and adjacent areas [e.g. *Corydoras julii* Steindachner, 1906, *Corydoras treitlii* Steindachner, 1906, *Knodus victoriae* (Steindachner, 1907), *Otocinclus hasemani* Steindachner, 1915, *Hemiodus parnaguai* Eigenmann & Henn, 1916, *Corydoras vittatus* Nijssen, 1971, *Pterygoplichthys parnaíbae* (Weber, 1991), *Auchenipterus menezesi* Ferraris & Vari, 1999, *Roeboides margareteae* Lucena, 2003, *Geophagus parnaíbae* Staack & Schindler, 2006, *Roeboides sazimai* Lucena, 2007, *Platydoras brachylecis* Piorski, Garavello, Arce H. & Sabaj Pérez, 2008, *Cichlasoma zarskei* Ottoni, 2011, *Poecilia sarrafae* Bragança & Costa, 2011, *Hypsolebias coamazonicus* Costa, Amorim & Bragança, 2014, *Anablepsoides vieirai* Nielsen, 2016, *Parotocinclus cabessadecua* Ramos, Lima & Ramos, 2017 and *Hypostomus sertanejo* Zawadzki, Ramos & Sabaj Pérez, 2017]. Studies on range extension and new records of some freshwater fishes from the area between the mouth of Rio Gurupi and Delta do

Rio Parnaíba (e.g. Barros et al. 2011, Matavelli et al. 2015, Guimarães et al. 2017a, 2017b, Lima et al. 2017), as well as the description of new species (cited above), suggest that the biogeographic history of the river basins of the region is complex and still poorly known. This region is an extremely ecologically relevant area since it comprises three of the main Brazilian biomes, as well as, transition zones between them: Amazônia, Brazilian Cerrado and Caatinga. Therefore, this area has faunal and floristic representatives of these three biomes, which makes it extremely relevant in terms of ecology, biodiversity and conservation (Olson, et al. 2001; Piorski et al. 2008, Fiaschi and Pirani 2009; Miranda et al. 2012).

Comparative material. *Charax caudimaculatus*: USNM 263877, 1, 95 mm SL, Laguna Cocococha, Reserva Nacional de Tambopata, Madre de Dios, **Peru**. (Radiograph of a Paratype). USNM 280291, 1, 95.0 mm SL, Laguna Cocococha, Reserva Nacional de Tambopata, Madre de Dios, **Peru**. (photograph of holotype).

Charax leticiae: all from **Brazil**: UFRJ: 1576, 4, 66.6–71.1, Goiás State, Aruanã municipality. CICCAA 00762, 2, 79.1–80.0 mm SL, Pará State, Parauapebas municipality. CPUFMA121858, 1, 81.0 mm SL, Maranhão state, stream at the Parque Estadual do Mirador (Rio Itapeturu basin), Mirador municipality.

Charax pauciradiatus: all from Maranhão State, **Brazil**. CICCAA00899, 3, 79.1–84.7. Maranhão State, Igarapé Papagaio, Tocantins river basin, São Pedro da Água Branca Municipality. CPFUMA10860, 6, 88.6–117.46, Igarapé mão-de-onça, Gurupi river basin, Centro Novo Municipality. CPUFMA00868, 9, 103.7–117.94, Gurupi river basin, Centro Novo Municipality. CPUFMA10869, 7, 98.5–113.0, Gurupi river basin, Centro Novo Municipality. CPUFMA11870, 8, 93.9–112.6, Gurupi river basin, Centro Novo Municipality. CPUFMA11871, 3, 89.1–113.2, Gurupi river basin, Centro Novo Municipality.

Charax notulatus: USNM: 360305, 1 (photograph of holotype), 77 mm SL, Guarico State, Cano Falcon, **Venezuela**.

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Supplementary material 1

Distribution of *Charax awa* sp.n., *C. leticiae*, *C. pauciradiatus*, and *C. niger*

Authors: Erick Cristofore Guimarães, Pâmella Silva De Brito, Beldo Rywllon Abreu Ferreira, Felipe Polivanov Ottoni

Data type: Microsoft Excel Worksheet (.xlsx)

Explanation note: Information of this map was based on our examined material and data provided by Menezes and Lucena (2014).

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APÊNDICE II: Artigo Publicado

Titulo: Range extension of *Gasteropelecus sternicla* (Characiformes) for three coastal river basins of the Eastern Amazon region as well as for the Itacaiunas River drainage of the Tocantins River basin

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Range extension of *Gasteropelecus sternicla* (Characiformes) for three coastal river basins of the Eastern Amazon region as well as for the Itacaiunas River drainage of the Tocantins River basin

by

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Nivaldo M. PIORSKI (2) & Jorge L.S. NUNES (3)

Résumé. – Extension de la répartition de *Gasteropelecus sternicla* (Characiformes) dans trois bassins fluviaux côtiers de l'Amazonie orientale, ainsi que pour la rivière Itacaiunas du bassin du Tocantins.

La répartition géographique de *Gasteropelecus sternicla* (Gasteropelecidae) est ici étendue à trois bassins côtiers de l'Amazonie orientale, dans l'état de Maranhão, au nord-est du Brésil. De plus, cette espèce est répertoriée pour la première fois dans le drainage du fleuve Itacaiunas, dans le bassin du Tocantins, dans l'état de Pará, au nord du Brésil. Nous présentons également quelques données méristiques des échantillons qui ont été examinés, et enfin des informations sur l'occurrence de cette espèce dans les autres états du Brésil.

Key words. – Characiformes – Gasteropelecidae – *Gasteropelecus sternicla* – Brazil – Eastern Amazon – Freshwater hatchfish – Taxonomy.

Gasteropelecidae is a family of freshwater Neotropical fishes, belonging to the order Characiformes and including three genera: *Gasteropelecus* Scopoli, 1777; *Thoracocharax* Fowler, 1907 and *Carnegiella* Eigenmann, 1909. These genera comprise three, two and four species, respectively (Weitzman and Palmer, 2003; Nelson *et al.*, 2016). These species are commercially collected for the aquarium trade (Weitzman and Palmer, 2003). The family, which occurs in Panama and all the South American countries except for Chile, is distributed along the river basins of the Amazon, Paraguay, Orinoco, Marowini and other Guiana shield rivers (Weitzman and Palmer, 2003). Gasteropelecid species, popularly known as hatchfishes, are easily recognized by their highly modified body, characterized by the presence of a conspicuous keel on the pectoral girdle, strong muscles, and long pectoral-fin rays (Weitzman, 1960; Géry, 1977; Weitzman and Palmer, 2003). These features allow them to perform long and high jumps out of the water (Weitzman and Palmer, 2003).

Gasteropelecus differs from the other two genera of the family by the following characters: adipose fin always present, 28-37 scales on longitudinal series, 0-1 outer premaxillary teeth and anal fin with iii+19-33 rays (22-36 total rays), while *Carnegiella* never

possesses adipose fin, and *Thoracocharax* possesses 19-22 scales on longitudinal series, three outer premaxillary teeth and anal fin with iii+31-42 rays (34-45 total rays) (Weitzman, 1960; Géry, 1977). Currently, *Gasteropelecus* comprises: *G. sternicla* (Linnaeus, 1758), *G. maculatus* Steindachner, 1879 and *G. levis* (Eigenmann, 1909). *Gasteropelecus sternicla* was originally described as *Clupea sternicla*, based on specimens collected in Surinam (Weitzman and Palmer, 2003). The geographical distribution of the species is known for the Amazon, Orinoco and Guiana shield river basins in Brazil, French Guyana, Guyana, Peru, Surinam and Venezuela (Weitzman and Palmer, 2003); it is also recorded in the Paraguay River, Brazil (Britski *et al.*, 2007). In Brazil, the species occurs in the following states: Acre, Amazonas, Goiás, Mato Grosso, Mato Grosso do Sul, Pará and Rondônia (Veríssimo *et al.*, 2005; Britski *et al.*, 2007; Costa *et al.*, 2008; Montag *et al.*, 2009; Abe *et al.*, 2013; Pires and Ohara, 2013; Suarez *et al.*, 2013).

Recently collected specimens of *G. sternicla* increase the knowledge on the range of three occurrences of this species.

MATERIALS AND METHODS

Specimens of *G. sternicla* (Fig. 1) were collected in nine sites of the following river drainages and basins: Pindaré River drainage of the Mearim River basin (five sites), Itapecuru River basin (one site), Munim River basin (one site) and Itacaiunas River drainage of the Tocantins River basin (two sites) (Fig. 2). The specimens were fixed for 15 days in formalin 10%, and then transferred into alcohol 70% for preservation. Measurements and counts followed Fink and Weitzman (1974). Information on teeth, rays, and internal counts were conducted in cleared and stained specimens (C&S), prepared according to Taylor and Van Dyke (1985). The four modified vertebrae that constitute the Weberian apparatus were not included in the vertebrae counts and the fused PU1 + U1 was considered as a single element. Information about other congeners of *Gasteropelecus* and other genera of Gasteropelecidae were based on Eigenmann (1909), Weitzman (1960), Géry (1977) and Weitzman and Palmer (2003). The material is deposited in Coleção Ictiológica do Centro de Ciências Agrárias Ambientais, da Universidade Federal do Maranhão (CICCA) and Coleção de Peixes da Universidade Federal do Maranhão (CPUFMA). Sampling was authorized by IBAMA

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Figure 1. – Preserved specimen of *G. sternicla*, CICCAA 00157, 36.9 mm SL; Alto Alegre municipality, Pindaré River drainage of the Mearim River basin, Maranhão State, northeastern Brazil.

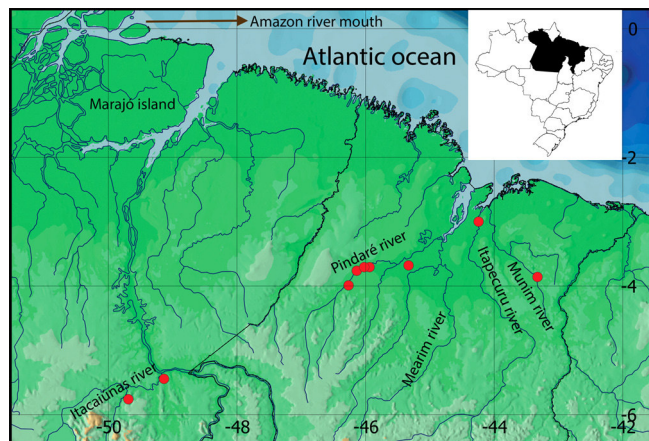


Figure 2. – Distribution (red circles) of *G. sternicla* in Pindaré River drainage of the Mearim River basin, Munim River basin, Itapecuru River basin and Itacaiunas River drainage of the Tocantins River basin, Maranhão and Pará states, Brazil.

and SISBIO through the documents N° 02001.007241/2004-37 and N° 42415, respectively.

Examined material

Gasteropelecus sternicla

Maranhão State: Alto Alegre do Pindaré municipality: CICCA 00157, 18 specimens, 30.58–44.6 mm SL; Igarapé Igarapá (Pindaré River drainage); 3°45'46"S–46°08'11"W; E. Guimarães and C. Costa; 03 Dec. 2015. CICCA 00158, 1 spm, 28.9 mm SL; Igarapé Presa de Porco (Pindaré River drainage); 3°59'25"S–46°15'51"W; E. Guimarães and C. Costa; 03 Dec. 2015. CICCA 00159, 40 spms, 26.1–33.5 mm SL; Igarapé Mineirão (Pindaré River drainage); 3°42'26"S–45°56'15"W; E. Guimarães and C. Costa; 03 Dec. 2015. CICCA 00161, 8 spms, 38.5–41.2 mm SL; Igarapé Brejinho (Pindaré River drainage); 3°42'27.54"S–46°01'17.00"W; E. Guimarães and C. Costa; 03 Dec. 2015. CICCA 00162, 5 (C&S) spms, 27.9–32.7 mm SL; Igarapé Brejinho (Pindaré River drainage); 3°42'27"S–46°01'17"W; E. Guimarães and C. Costa; 03 Dec. 2015.

Monção municipality: CICCA 00160, 63 spms, 33.2–42.1 mm SL; Bacia 814/815 (Pindaré River drainage); 3°40'48"S–45°19'51"W; E. Guimarães and C. Costa; 03 Dec. 2015. CICCA 00210, 4 (C&S) spms, 24.9–38.1 mm SL; Bacia 814/815 (Pindaré River drainage); 3°40'48"S–45°19'51"W; E. Guimarães and C. Costa; 03 Dec. 2015.

Chapadinha municipality: CICCA00211, 2 (C&S) spms, 32.6–38.2 mm SL; Munim River; 03°3'50"20"S–43°19'45"W; J. Nunes; 21 Nov. 2010.

Rosário municipality: CPUFMA 121125, 3 (C&S) spms, 28.9–41.1 mm SL; Itapecuru River, 2°59'58"S–44°14'32"W; N. Piorski; 03 Nov. 2012. CPUFMA 121125, 23 spms, 27.9–37.1 mm SL; Itapecuru River, 2°59'58"S–44°14'32"W; N. Piorski; 03 Nov. 2012.

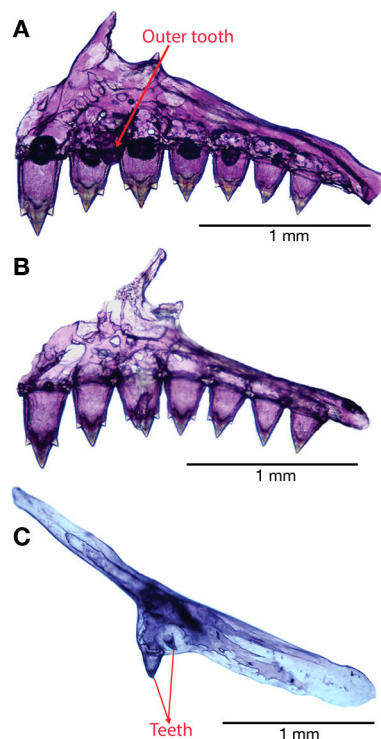


Figure 3. – Premaxilla of *G. sternicla*. A: CICCA 00162, 31.4 mm SL, C&S; Pindaré River drainage of the Mearim River basin, Maranhão state, northeastern Brazil. B: CICCA 00211, 32.6 mm SL, C&S; Munim River basin, Maranhão state, northeastern Brazil. C: Maxillary of *G. sternicla*, CICCA 00162, 31.4 mm SL, C&S; Pindaré River drainage of the Mearim River basin, Maranhão State, northeastern Brazil.

Pará State: Marabá municipality: CICCA 00212, 14 spms, 31.4–33.7 mm SL; Sororó River (Itacaiunas River drainage), 5°26'37"S–49°08'05"W; E. Guimarães and C. Costa; 03 Dec. 2015.

Parauapebas municipality: CICCA00213, 1 spm, 28.6 mm SL; Rio Castanheira (Itacaiunas River drainage), 5°45'31"S–49°41'17"W; E. Guimarães and C. Costa; 03 Dec. 2015. CICCA00214, 1 (C&S) spm, 25.8 mm SL; Castanheira River (Itacaiunas River drainage), 5°45'31"S–49°41'17"W; E. Guimarães and C. Costa; 03 Dec. 2015.

Thoracocharax stellatus

CICCA00215, 2 (C&S) spms, 30.8–33.2 mm SL; Sororó River (Itacaiunas River drainage), 5°45'31"S–49°41'17"W; E. Guimarães and C. Costa; 03 Dec. 2015.

CICCA00241, 4 spms, 51.3–49.4 mm SL; Sororó River (Itacaiunas River drainage), 5°45'31"S–49°41'17"W; E. Guimarães and C. Costa; 03 Dec. 2015.

RESULTS

The specimens of *Gasteropelecus* herein examined (Fig. 1) possess the following diagnostic character states of *G. sternicla*: absence of the sixth circumorbital bone and the outer premaxillary tooth rarely present (Fig. 3A, B), versus presence of the sixth circumorbital bone and the outer premaxillary tooth in both *G. levis* and *G. maculatus* (Weitzman, 1960; Géry, 1977); maxillary toothed (Fig. 3C) and larger body, while *G. levis* has maxillary not toothed, and a smaller body; and body without spots, while the body of *G.*

Table I. – Meristic data of *Gasteropelecus sternicla* herein examined.

	Mearim basin		Itapecuru basin		Munim basin		Tocantins basin	
	Nº	Range	Nº	Range	Nº	Range	Nº	Range
Number of dorsal-fin rays	9	11	3	11	2	11	1	11
Number of anal-fin rays	9	33-34	3	33-34	2	32	1	33
Number of pectoral-fin rays	9	11	3	11	2	11	1	11
Number of pelvic-fin rays	9	5	3	5	2	5	1	5
Number of scales in the longitudinal series	12	29-33	6	28-33	2	27-31	7	28-32
Number of maxillary teeth	9	2 - 3	3	2-3	2	2-5	1	2
Number of teeth in the outer row of premaxilla	9	absent	3	absent	2	1	1	absent
Number of teeth in the inner row of premaxilla	9	7-8	3	8	2	7-8	1	7
Number of teeth in the dentary	9	11-14	3	10-12	2	12	1	12
Number of branchiostegal rays	3	5	1	5	2	5	1	5
Number of supraneurals	9	11-12	3	11	2	11-12	1	12
Number of principal caudal-fin rays	6	21	3	21	2	21	1	21
Number of dorsal procurent rays	6	6	3	6	2	6	1	6
Number of ventral procurent rays	6	6	3	6	2	6	1	6
Number of vertebrae	9	29-30	3	29-30	2	30	1	29
Number of rib pairs	9	8	3	8	2	8	1	8

maculatus is spotted (Géry, 1977). Some meristic information of the specimens herein examined are presented in the table I.

DISCUSSION AND CONCLUSIONS

The present study expands the distribution of *G. sternicla*. The previously known eastern distribution limit for the Amazon River basin was in the Marajó Island of the Pará State (Montag *et al.*, 2009). We extended the species distribution for the following coastal river drainages and basins of the Maranhão State: Pindaré River drainage of the Mearim River basin, Itapecuru River basin and Munim River basin, as well as for the Itacaiunas River drainage of the Tocantins River basin, Pará state (Fig. 2).

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APÊNDICE III: Artigo Publicado

Titulo: Range extension of *Piabucus dentatus* (Koelreuter, 1763) for the Pindaré River drainage, Mearim River basin, Brazil (Characiformes: Iguanodectinae)

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Range extension of *Piabucus dentatus* (Koelreuter, 1763) for the Pindaré River drainage, Mearim River basin, Brazil (Characiformes: Iguanodectinae)

by

Erick C. GUIMARÃES (1), Felipe P. OTTONI* (1) & Axel M. KATZ (2)

Résumé. – Extension de la répartition de l'espèce *Piabucus dentatus* (Koelreuter, 1763) dans le fleuve Pindaré, bassin du Mearim, au nord-est du Brésil (Characiformes: Iguanodectinae).

Cette étude présente l'extension de la répartition de *Piabucus dentatus* dans le réseau hydrographique de la rivière Pindaré, bassin du fleuve Mearim, dans l'état de Maranhão, au nord-est du Brésil. La répartition géographique de cette espèce était connue auparavant uniquement dans les réseaux hydrographiques situés le long de la côte du golfe Paria, au Vénézuéla, et jusqu'au sud de l'embouchure du fleuve Amazone. C'est le premier signalement de cette espèce au nord-est du Brésil, et également le premier signalement de ce genre dans cette région. Des données méristiques des spécimens sont présentées et les caractères diagnostiques de *P. dentatus* sont discutés. Certaines données méristiques présentées ici sont les premières à être publiées sur cette espèce.

Key words. – Characidae - *Piabucus dentatus* - Brazil - Maranhão state - Taxonomy - Range extension.

The Iguanodectinae is a subfamily of the Neotropical fish family Characidae, comprising about 30 valid species (Moreira, 2003; Nelson *et al.*, 2016). Species of genus *Piabucus* Oken, 1817 are distributed along the Atlantic river drainages of South America, from the Orinoco River basin in the north through most of the rivers of the Amazon River basin, to the Paraguay River basin in the south (Vari, 1977). Its members are characterized mainly by having an elongated, basally-contracted body, multicuspid teeth, gill-membranes united and free from the isthmus, posterior end of maxilla not extending to the eyes, dorsal-fin origin usually located posteriorly to the middle of body, and a long anal fin (Moreira, 2003).

The genus *Piabucus* is distinguished from *Iguanodectes* Cope, 1872, its most similar genus, by having a longer pectoral fin and a compressed thoracic and preentral region, terminating ventrally in a well-developed keel (Vari, 1977; Moreira, 2003); it currently comprises only three valid species (Nelson *et al.*, 2016): *Piabucus caudomaculatus* Vari, 1977, *P. dentatus* (Koelreuter, 1763), and *P. melanostoma* Holmberg, 1891. *Piabucus dentatus* was originally described as *Trutta dentata* (Moreira, 2003). The geographical distribution of the species is known from the coastal drainages of Paria Gulf in Venezuela to the mouth of the Amazon River, including the lower Amazon River basin, in Brazil, French Guiana, Guyana, Suriname, and Venezuela (Géry, 1977; Planquette *et al.*, 1996;

Moreira, 2003). We have found this species in the Pindaré River drainage of the Mearim River basin, northeastern Brazil, expanding its distribution about 400 km further southeast.

MATERIALS AND METHODS

The specimens of *Piabucus dentatus* were collected at two sites of the Pindaré River drainage, Mearim River basin, northeastern Brazil (Fig. 1). The specimens were fixed in 10% formaldehyde solution, and then transferred to 70% ethanol for preservation. Measurements and counts followed Fink and Weitzman (1974). Data related to fin rays, branchiostegal rays, teeth, supraneurals, vertebrae, and ribs, were conducted in the three cleared and stained specimens (C&S) after Taylor and Van Dyke (1985). The other data were taken from the seven not cleared and stained specimens. The Weberian apparatus were not included in the vertebral count and the fused PU1+U1 was considered a single element. Comparison to congeners was based on Géry (1977), Vari (1977), Moreira (2003), and Lima *et al.* (2013). The collected material was deposited in the Coleção Ictiológica do Centro de Ciências Agrárias Ambientais (CICCA) of the Universidade Federal do Maranhão.

Examined material

Brazil: Maranhão State: Alto Alegre do Pindaré municipality: CICCA 00095, 3 specimens, C&S, 75.2-91.2 mm SL; Igarapé do Fausto, 3°42'47.45"S-46°3'26.26"W; E. Guimarães and C. Costa, 03 Dec. 2015. CICCA 00096, 6 spms, 100.1-102.1 mm SL; Igarapé do Fausto, 3°42'47.45"S-46°3'26.26"W; E. Guimarães and C. Costa, 03 Dec. 2015. CICCA 00097, 1 spm, 94.8 mm SL; Igarapé Mineirão, 3°42'26.96"S-45°56'15.12"W, E. Guimarães and C. Costa, 03 Dec. 2015.

RESULTS

The specimens (Fig. 2) were identified as *Piabucus dentatus*, as having two rows of teeth on premaxilla (inner row with six teeth, and outer row with one smaller tooth) (Fig. 3), while the other two congeneric species possess only one row of teeth. The meristics of *P. dentatus* are similar to those of *P. melanostoma* (Géry, 1977), differing from *P. caudomaculatus* by the following features: presence of adipose fin (Fig. 2C), 80-84 (vs. 75-76) perforated scales in the lateral line, 11 (vs. 8-9) dorsal-fin rays and 45-46 (vs. 36-38) total anal-fin rays.

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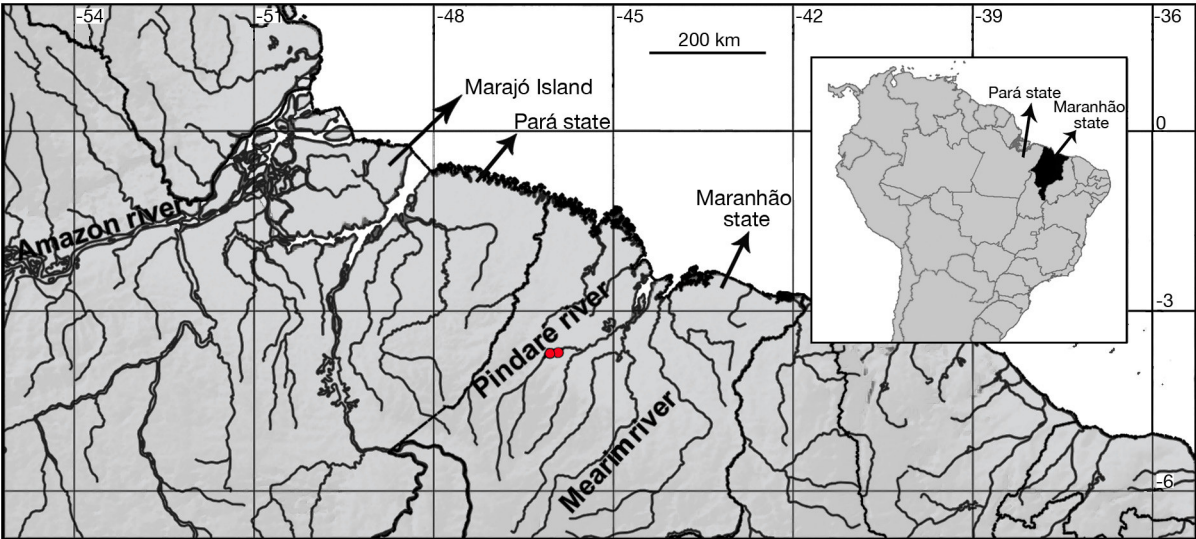


Figure 1. – New records of *Piabucus dentatus* (red circles) in the Pindaré River drainage, Mearim River basin, Maranhão state, northeastern Brazil.

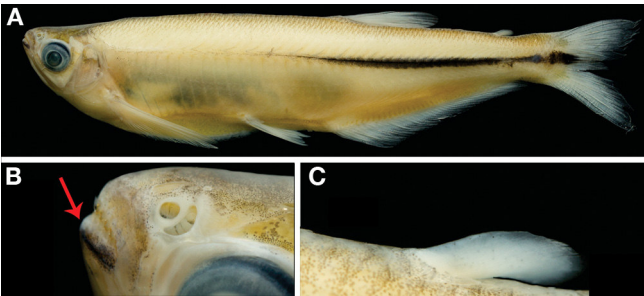


Figure 2. - *Piabucus dentatus*: CICCA 00096, 100.9 mm SL: Pindaré River drainage, Mearim River basin, Maranhão state, northeastern Brazil. **A**: Lateral view; **B**: Lateral view of head (red arrow showing dark pigmentation of lower jaw); **C**: Adipose fin.

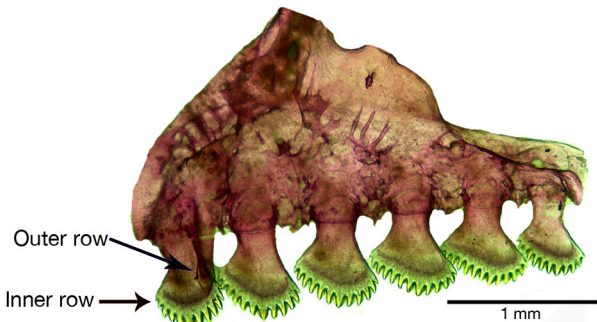


Figure 3. – Premaxilla of *Piabucus dentatus*, CICCA 00095, 91.2 mm SL, C&S, Pindaré River drainage, Mearim River basin, Maranhão state, northeastern Brazil.

Table I. – Meristic data of the examined specimens from the Pindaré River drainage.

	N	Range
Number of dorsal-fin rays	3	iii+8
Number of anal-fin rays	3	45-46
Number of pectoral-fin rays	3	13
Number of pelvic-fin rays	3	8
Number of perforated scales of lateral line	7	80-84
Number of maxillary teeth	3	2 (10-13 cuspids)
Number of teeth in the inner row of premaxilla	3	6 (10-13 cuspids)
Number of teeth in the outer row of premaxilla	3	1 (3-5 cuspids)
Number of teeth in the dentary	3	10 (10-13 cuspids)
Number of branchiostegal rays	3	4
Number of supraneurals	3	11
Number of principal caudal-fin rays	3	22
Number of dorsal procurrent rays	3	9
Number of ventral procurrent rays	3	8
Number of vertebrae (precaudal + caudal)	3	41-43 (21-23 +20-22)
Number of rib pairs	3	21
Number of pterigiophores on dorsal/anal-fin bases	3	10/40

DISCUSSION

The present study extends the distribution of *P. dentatus* for the Pindaré River drainage of the Mearim River basin, northeastern Brazil (Fig. 1), which had never been recorded for this River basin (see Moreira, 2003; Soares, 2013). It represents a distribution expansion of about 400 km further southeast. Moreover, this is the first record of the genus for the northeast of Brazil. Specimens of the genus *Piabucus* are rarely collected on fish expeditions, with few collecting sites records (Géry, 1977; Borba *et al.*, 2013; Lima *et al.*, 2013). This justifies why this is the first record of the genus for northeastern Brazil, and more precisely, for the Maranhão state. In addition, we present some additional meristic data of the specimens herein examined in table I. Some of these meristic data are the first recorded for the species.

According to Vari (1977), *P. dentatus* does not possess dark pigmentation in the lower jaw, what distinguishes it from both *P. melastoma* and *P. caudomaculatus*, which display that dark pigmentation. However, this information was not confirmed by the present study, which revealed the presence of this dark pigmentation in the specimens of *P. dentatus* herein examined (Fig. 2B). Probably, Vari (1977) could not record

this dark pigmentation due to the state of preservation of the specimens he examined. Some specimens of our examined material do not possess this dark pigmentation of the lower jaw so conspicuous. Thus, this colour pattern is not a useful and reliable taxonomic character.

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APÊNDICE IV: Artigo Publicado

Titulo: A new species of *Hyphessobrycon* Durbin from northeastern Brazil: evidence from morphological data and DNA barcoding (Characiformes, Characidae)

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A new species of *Hyphessobrycon* Durbin from northeastern Brazil: evidence from morphological data and DNA barcoding (Characiformes, Characidae)

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Abstract

A new species of *Hyphessobrycon* is described for the upper Munim and Preguiças river basins, northeastern Brazil, supported by morphological and molecular species delimitation methods. This new species belongs to the *Hyphessobrycon sensu stricto* group, as it has the three main diagnostic character states of this assemblage: presence of a dark brown or black blotch on the dorsal fin, absence of a black midlateral stripe on its flank and the position of Weberian apparatus upward horizontal through dorsal margin of operculum. Our phylogenetic analysis also supported the allocation of the new species in this group; however, it was not possible to recover the species sister-group. *Pristella maxillaris* and *Moenkhausia hemigrammoides* were recovered as the sister-clade of the *Hyphessobrycon sensu stricto* group.

Resumo

Uma nova espécie de *Hyphessobrycon* é aqui descrita para as bacias do alto Rio Munim e Preguiças, nordeste do Brasil, sustentada por métodos morfológicos e moleculares de delimitação de espécies. Essa nova espécie é membro do grupo *Hyphessobrycon sensu stricto*, já que possui os três principais estados de caracteres diagnósticos desse agrupamento: presença de uma mancha marrom escura ou negra na nadadeira dorsal, ausência de uma faixa lateral no meio do flanco e a posição do aparelho de Weber localizado acima da horizontal da margem dorsal do opérculo. Nossa análise filogenética também apoia o posicionamento da nova espécie dentro desse grupo, entretanto não foi possível recuperar o grupo-irmão da espécie. *Pristella maxillaris* e *Moenkhausia hemigrammoides* foram recuperados com sendo o clado irmão do grupo *Hyphessobrycon sensu stricto*.

Keywords

Hyphessobrycon sensu stricto, integrative taxonomy, Pristellinae, rosy tetra clade

Palavras-chave

clado rosy tetra, *Hyphessobrycon sensu stricto*, taxonomia integrativa, Pristellinae

Introduction

Hyphessobrycon Durbin, 1908 is one of the most species-rich genera of Characidae, currently comprising approximately 150 valid species (Ohara et al. 2017). It is widely distributed along the river basins of the Neotropical region, from southern Mexico to the La Plata River basin in northeastern Argentina (Carvalho and Malabarba 2015, Teixeira et al. 2015, García-Alzate et al. 2017), with highest diversity in the Amazon basin (Miquelarena and López 2006, Lima et al. 2013, Bragança et al. 2015, Carvalho and Malabarba 2015, Marinho et al. 2016, Carvalho et al. 2017, Moreira and Lima 2017).

Extensive data show that *Hyphessobrycon* is not a monophyletic group (Carvalho et al. 2017, Moreira and Lima 2017). It was diagnosed by an artificial combination of character states proposed by Eigenmann (1917), such as: the presence of an adipose fin; maxillary with few teeth or none; lateral line incomplete; third infraorbital bone not in contact with the sensory canal of the preopercle; premaxillary with two series of teeth; and caudal-fin lobes without scales at the base. Nevertheless, new species descriptions continue to follow this artificial combination (e.g., Ohara et al. 2017, García-Alzate et al. 2017, Carvalho et al. 2017, Moreira and Lima 2017).

In addition, some artificial species groups of *Hyphessobrycon* were proposed based on the combination of character states (e.g., Weitzman and Palmer 1997, Zarske 2014, García-Alzate et al. 2008a, b, 2013, Carvalho and Malabarba 2015) relying mainly on coloration patterns. However, in many cases, it is not possible to assign without reasonable doubt to which group a particular species belongs (Bragança et al. 2015).

One of this species group was termed as “group F” by Géry (1977), being defined by the presence of a dark brown or black blotch on dorsal fin and no midlateral stripe on body. This group was previously termed as “*callistus* group”, with a similar composition and definition by Géry (1961). Weitzman and Palmer (1997) proposed the name “rosy tetra clade” for this assemblage, including approximately 30 species of *Hyphessobrycon*

and a few other probably closely related species belonging to other genera. These authors also confirmed the presence of the black blotch on the dorsal fin as one of the main diagnostic features of this assemblage. However, they also stated that this blotch was absent in some of its species (e.g., *H. ecuadoriensis* Eigenmann & Henn, 1914, *H. loweae* Costa & Géry, 1994 and *H. panamensis* Durbin, 1908).

After that, Carvalho (2011) and Carvalho and Malabarba (2015) proposed the group named *Hyphessobrycon sensu stricto*, diagnosed by the position of Weberian apparatus upward horizontal through dorsal margin of operculum, presence of a black blotch on dorsal fin and the absence of a midlateral black stripe on body, with a more restricted composition than the “rosy tetra clade” *sensu* Weitzman and Palmer (1997), comprising: *H. compressus* (Meek, 1904), *H. bentosi* Durbin, 1908, *H. copelandi* Durbin, 1908, *H. epicharis* Weitzman & Palmer, 1997, *H. eques* (Steindachner, 1882), *H. erythrostigma* (Fowler, 1943), *H. georgettae* Géry, 1961, *H. haraldschultzi* Travassos, 1960, *H. hasemani* Fowler, 1913, *H. khardinae* Zarske, 2008, *H. megalopterus* (Eigenmann, 1915), *H. micropterus* (Eigenmann, 1915), *H. minor* Durbin, 1909, *H. pulchripinnis* Ahl, 1937, *H. pyrrhonotus* Burgess, 1993, *H. rosaceus* Durbin, 1909, *H. roseus* (Géry, 1960), *H. simulatus* (Géry, 1960), *H. socolofi* Weitzman, 1977, *H. sweglesi* (Géry, 1961), *H. takasei* Géry, 1964 and *H. werneri* Géry & Uj, 1987. Other species recently referred to the “rosy tetra clade” such as *Hyphessobrycon dorsalis* Zarske, 2014, *H. jackrobertsi* Zarske, 2014, *H. paepkei* Zarske, 2014 and *H. pando* Hein, 2009 share these traits, but their taxonomic status is uncertain (Carvalho and Malabarba 2015). The key point is that the remaining species of *Hyphessobrycon* included in the other groups will probably need to be assigned to other genera or new genera (*Hyphessobrycon sensu lato*) (Carvalho and Malabarba 2015).

One way to overcome the confusing taxonomy of problematic groups, to have accurate species identifications and species diversity estimates of groups is to use different operational criteria for species delimitation (Goldstein and Desalle 2010, Padial et al. 2010). Any operational criteria (species delimitation methods) may separately provide evidence about the species limits and identity independently from other criteria (de Queiroz 2005, 2007), but evidence corroborated from multiple operational criteria is considered to produce stronger hypotheses of lineage divergence (de Queiroz 2007, Goldstein and Desalle 2010), converging to the proposal for an integrative taxonomy (Goldstein and Desalle 2010, Padial et al. 2010). Gathering morphological and molecular data has become a common practice to identify and delimit species of fish (Teletchea 2009), mainly in groups including cryptic or morphologically similar species. The most widespread molecular method used in taxonomy has been the DNA barcoding, which consists on the use of a single gene from mitochondrial DNA (cytochrome oxidase subunit I – COI) as a proxy for species differentiation (Hebert et al. 2003). In fact, several studies have been carried out using molecular markers and new species have been delimited and/or described, in most cases, based both on molecular and morphological evidence (e.g., Costa and Amorim 2011, Costa et al. 2012, Roxo et al 2012, Villa-Verde et al. 2012, Castro-Paz et al. 2014, Costa et al. 2014, Benzaquem et al 2015, Mattos et al. 2015, Costa et al. 2017).

A new species of *Hyphessobrycon*, member of the *Hyphessobrycon sensu stricto* Carvalho and Malabarba, 2015 is herein described from the Munim and Preguiças river basins, two coastal river basins of the Maranhão State, northeastern Brazil, based on both morphology and molecular data.

Materials and methods

Morphological analysis

Measurements and counts were made according to Fink and Weitzman (1974), with exception for the scale rows below lateral line, which were counted to the insertion of pelvic fin. Horizontal scale rows between the dorsal-fin origin and lateral line do not include the scale of the median predorsal series situated just anterior to the first dorsal-fin ray. Counts of supraneurals, vertebrae, procurent caudal-fin rays, unbranched dorsal and anal fin rays, branchiostegal rays, gill-rakers, premaxillary, maxillary, and dentary teeth were taken only from cleared and stained paratypes (C&S), prepared according to Taylor and Van Dyke (1985). The four modified vertebrae that constitute the Weberian apparatus were not included in the vertebra counts and the fused PU1 + U1 was considered as a single element. Osteological nomenclature follows Weitzman (1962). Institutional abbreviations follow Sabaj-Pérez (2016), with addition of **CICCAA** Coleção Ictiológica do Centro de Ciências Agrárias e Ambientais and **CPUFMA** Coleção de Peixes da Universidade Federal do Maranhão.

Comparative material examined

All specimens are from Brazil.

Hyphessobrycon amandae Géry & Uj, 1987: UFRJ 1557, 5 spcms, Goiás State, Jussara municipality. *H. bentosi*: CICCAA 00849, 2 spcms, aquarium trade. *H. cf. bentosi*: CICCAA 00701, 1 spcm, Pará State, Paragominas municipality. CICCAA 00702, 2 spcms, Pará State, Paragominas municipality. CICCAA 00703, 1 spcm (C&S), Pará State, Paragominas municipality. *H. bifasciatus* Ellis, 1911: UFRJ 0068, 6 spcms, Espírito Santo State, Marataízes and Guarapari municipality. *H. copelandi*: CICCAA 00722, 2 spcms, Pará State, Marabá municipality. *H. diancistrus* Weitzman, 1977: UFRJ 2166, 55 spcms, Tocantins State, Ilha do Bananal municipality. *H. eques*: CICCAA 00715, 4 spcms (C&S), Minas Gerais State, Tombos municipality. CICCAA 00710, 51 spcms, Minas Gerais State, Tombos municipality. *H. griemi* Hoedeman, 1957: UFRJ 4496, 7 spcms, Santa Catarina State, Esplanada municipality. *H. haraldschultzi*: CICCAA 00873, 20 spcms, Tocantins State, Ilha do Bananal municipality. *H. itaparicensis* Lima & Costa, 2001: CICCAA 00314, 6 spcms, Sergipe State, Areia Branca municipality. *Pristella maxillaris* (Ulrey, 1894): CICCAA 00850, 2 spcms, aquarium trade. *H. micropterus*: FMNH 57916,

1 spcm, Rio São Francisco at Lagoa do Porto (Photograph of a Holotype). CICCAA 00300, 24 spcms, Bahia; Barras municipality. CICCAA 00699, 8 spcms (C&S), Barras, Bahia municipality. *H. reticulatus* Ellis, 1911: UFRJ 0107, 4 spcms, Rio de Janeiro State, Desengano municipality. *H. sergipanus* Bragança, Ottoni & Rangel-Pereira, 2016: CICCAA 00296, 11 spcms, Sergipe State, Estância municipality. UFRJ 5582, 8 spcms, Mato Grosso State, Poconé municipality. UFRJ 3937, 4 spcms, Mato Grosso State, Cárceres municipality. *H. stegemanni* Géry, 1961: UFRJ 1988, 17 spcms, Tocantins State, Porto Nacional municipality. *H. sweglesi*: CICCAA 00852, 2 spcms, trade aquarium. *H. wernerei*: MUZUSP 42365, 1 spcm, Pará State, Santa Maria do Pará municipality. CICCAA 00751, 1 spcm, Pará State, Paragominas municipality.

DNA extraction, amplification, and sequencing

DNA extraction was carried out with the Wizard Genomic DNA Purification kit (Promega) following manufacturer's protocol. DNA quality was evaluated by agarose gel electrophoresis stained with GelRed (Biotium) and was quantified using Nanodrop 2000 (Thermo Fisher Scientific). DNA was stored at -20 °C until further procedures. Samples (N= 4; Table 1) were amplified using standard PCR (Polymerase Chain Reaction) for partial cytochrome oxidase subunit 1 (COI) gene, with primers designed by Ward et al. (2005) (FISHF1 5'-TCAACCAACCACAAAGACATTGGCAC-3' and FISHR1 5'-TAGACTTCTGGGTGGCCAAAGAATCA-3'). Amplification reactions were performed in a total volume of 15 µl comprising 1× buffer, 1.5 mM MgCl₂, 200 µM dNTP, 0.2 uM of each primer, 1 U of Taq Polymerase (Invitrogen), 100 ng of DNA template, and ultrapure water. The amplification program consisted of a denaturation of 2 min at 94 °C, followed by 35 cycles of 30s at 94 °C, 30s at 54 °C, and 1 min at 72 °C, ending in an extension phase of 10 min at 72 °C. Amplicons were visualized in 1% agarose gel electrophoresis stained with GelRed (Biotium) and purified with Illustra GFX PCR DNA and Gel Purification Kit (GE Healthcare). Samples were sequenced using both forward and reverse primers and BigDye Terminator kit 3.1 Cycle Sequencing kit (Thermo Fisher Scientific) in ABI 3730 DNA Analyser (Thermo Fisher Scientific). Consensus sequences were edited in Geneious 9.0.5 (Kearse et al. 2012) and aligned using ClustalW (Thompson 1994) with those from *Hyphessobrycon* species available in Barcode of Life Database (BOLD) and Genbank (NCBI-National Center for Biotechnology Information) (accession numbers are in Table 1).

Species concept, species delimitation, and diagnoses

The unified species concept (de Queiroz 2005, 2007) is herein adopted by expressing the conceptual definition shared by all traditional species concepts – “species are (segments of) separately evolving metapopulation lineages” – when operational criterion elements to delimit taxa are excluded from the concepts. According to this concept,

Table 1. Sampling sites, specimens and DNA sequence information included in the study.

Species	Locality	Basin/ drainage	Country	GenBank/ BoldSystems	Catalog number
<i>Hyphessobrycon piorskii</i> sp. n.	Anapurus, Maranhão	Munim	Brazil	MF765796	CICCAA00725
<i>Hyphessobrycon piorskii</i> sp. n.	Anapurus, Maranhão	Munim	Brazil	MF765797	CICCAA00726
<i>Hyphessobrycon piorskii</i> sp. n.	Barreirinhas, Maranhão	Preguiças	Brazil	MG791915	CICCAA01650
<i>Hyphessobrycon piorskii</i> sp. n.	Anapurus, Maranhão	Munim	Brazil	MG791914	CICCAA01651
<i>Hyphessobrycon bentosi</i>	Barcelos, Amazonas	Negro	Brazil	HYP097-13	INPA37684-5939
<i>Hyphessobrycon bentosi</i>	Barcelos, Amazonas	Negro	Brazil	HYP098-13	INPA37684-5940
<i>Hyphessobrycon bentosi</i>	Barcelos, Amazonas	Negro	Brazil	HYP099-13	INPA37684-5942
<i>Hyphessobrycon bentosi</i>	Barcelos, Amazonas	Negro	Brazil	HYP100-13	INPA37684-5943
<i>Hyphessobrycon bentosi</i>	Manaus, Amazonas	—	Brazil	HYP116-13	INPA39527-BA1
<i>Hyphessobrycon bentosi</i>	Manaus, Amazonas	—	Brazil	HYP117-13	INPA39527-BA2
<i>Hyphessobrycon bentosi</i>	Manaus, Amazonas	—	Brazil	HYP118-13	INPA39527-BA3
<i>Hyphessobrycon bentosi</i>	Manaus, Amazonas	—	Brazil	HYP119-13	INPA39527-BA4
<i>Hyphessobrycon copelandi</i>	Tabatinga, Amazonas	Solimões	Brazil	HYP094-13	INPA37683-TU1
<i>Hyphessobrycon copelandi</i>	Tabatinga, Amazonas	Solimões	Brazil	HYP095-13	INPA37683-TU1
<i>Hyphessobrycon copelandi</i>	Tabatinga, Amazonas	Solimões	Brazil	HYP096-13	INPA37683-TU1
<i>Hyphessobrycon eques</i>	Santarém, Pará	Amazonas	Brazil	HYP070-13	INPA37678-IC2
<i>Hyphessobrycon eques</i>	Parintins, Amazonas	Amazonas	Brazil	HYP072-13	INPA37680-AL1
<i>Hyphessobrycon erythrostigma</i>	Tabatinga, Amazonas	Solimões	Brazil	HYP073-13	INPA37681-AP1
<i>Hyphessobrycon erythrostigma</i>	Tabatinga, Amazonas	Solimões	Brazil	HYP074-13	INPA37681-AP2
<i>Hyphessobrycon epicharis</i>	São Gabriel da Cachoeira, Amazonas	Negro	Brazil	HYP002-13	INPA37665-JUF1
<i>Hyphessobrycon epicharis</i>	São Gabriel da Cachoeira, Amazonas	Negro	Brazil	HYP003-13	INPA37665-JUF2
<i>Hyphessobrycon megalopterus</i>	—	—	—	FJ749058	—
<i>Hyphessobrycon megalopterus</i>	—	—	—	KU568879.1	—
<i>Hyphessobrycon pyrrhonotus</i>	Santa Isabel do rio Negro, Amazonas	Negro	Brazil	HYP039-13	INPA37672-TRO1
<i>Hyphessobrycon pyrrhonotus</i>	Santa Isabel do rio Negro, Amazonas	Negro	Brazil	HYP040-13	INPA37672-TRO10
<i>Hyphessobrycon pyrrhonotus</i>	Santa Isabel do rio Negro, Amazonas	Negro	Brazil	HYP042-13	INPA37672-TRO2
<i>Hyphessobrycon socolofi</i>	Santa Isabel do rio Negro, Amazonas	Negro	Brazil	HYP020-13	INPA37667-UR1
<i>Hyphessobrycon socolofi</i>	Santa Isabel do rio Negro, Amazonas	Negro	Brazil	HYP022-13	INPA37667-UR7
<i>Hyphessobrycon rosaceus</i>	São Gabriel da Cachoeira, Amazonas	Negro	Brazil	HYP032-13	INPA37669-MAC4
<i>Hyphessobrycon rosaceus</i>	Nova Airão, Amazonas	Negro	Brazil	HYP069-13	INPA37677-FU1
<i>Hyphessobrycon rosaceus</i>	São Gabriel da Cachoeira, Amazonas	Negro	Brazil	HYP082-13	INPA37682-ACA1
<i>Hyphessobrycon sweglesi</i>	São Gabriel da Cachoeira, Amazonas	Negro	Brazil	HYP024-13	INPA37668-JAR1
<i>Hyphessobrycon sweglesi</i>	São Gabriel da Cachoeira, Amazonas	Negro	Brazil	HYP025-13	INPA37668-JAR2
<i>Hyphessobrycon sweglesi</i>	São Gabriel da Cachoeira, Amazonas	Negro	Brazil	HYP028-13	INPA37668-JAR5
<i>Moenkhausia hemigrammoides</i>	Rupununi Road-Guyana	—	Guyana	HYP101-13	INPA38532-PR1

Species	Locality	Basin/ drainage	Country	GenBank/ BoldSystems	Catalog number
<i>Pristella maxillaris</i>	–	–	–	KU568982.1	–
<i>Pristella maxillaris</i>	–	–	–	KU568981.1	–
<i>Hyphessobrycon flammeus</i>	–	–	Brazil	FUPR988-09	LBPV-40464
<i>Hyphessobrycon anisitsi</i>	–	–	Brazil	GBGCA516-10	FJ749040

species are treated as hypothetical and could be tested by the application of distinct criteria (species delimitation methods) (de Queiroz 2005, 2007). It allows for any criteria to separately provide evidence about species limits and identities, independently from other criteria (de Queiroz 2005, 2007). Evidence corroborated from multiple operational criteria is considered to produce stronger hypotheses of lineage separation (de Queiroz 2007, Goldstein and Desalle 2010), a practice called “integrative taxonomy” (Dayrat 2005, Goldstein and Desalle 2010, Padial et al. 2010).

Two distinct operational criteria to delimit species, based on morphological and molecular data, were implemented here. The Population Aggregation Analysis (Davis and Nixon 1992) is a character-based method (hereafter PPA), which consists of an exclusive shared combination of character states assigned to a given population or group of populations. The second method, DNA barcoding, as proposed by Hebert et al. (2003 a, b, 2004 a, b) (hereafter DBC), is a genetic distance-based cut-off method.

Population Aggregation Analysis (PAA)

Only morphological character states were used for this method. The morphological data was based on both examined material (see Comparative material examined) and the literature (e.g., Géry 1977, Géry and Uj 1987, Costa and Géry 1994, Plaquete et al. 1996, Weitzman and Palmer 1997, Zarske 2008, Hein 2009, Carvalho 2011, Lima et al. 2013, Zarske 2014, Carvalho and Malabarba 2015, Carvalho et al. 2017). The data obtained by this method are presented in the diagnosis section of results.

DNA barcoding (DBC)

Pairwise genetic distances between species were calculated using Kimura-2-parameters model (K2P) (Kimura 1980) on the MEGA 7 software (Tamura et al. 2011). Evolutionary relationships among sequences were reconstructed by Bayesian inference using the MrBayes (Huelsenbeck and Ronquist 2001) plugin in Geneious 9.0.5. An independent run with a chain length of 10 million, a burn-in length of 500,000 generations, and subsampling trees every 10,000 generations was carried out under the GTR (generalized time reversible) evolutionary model, which was estimated in jmodeltest (Darriba et al. 2012). *Hyphessobrycon flammeus* Myers, 1924 and *H. anisitsi* (Eigenmann, 1907) were used as outgroup. The ingroup was composed by the remaining terminals.

Results

Hyphessobrycon piorskii sp. n.

<http://zoobank.org/379CFBEA-C3FE-4729-9469-029732DC62BC>

Figures 1, 2

Holotype. CICCAA 00695, 25.9 mm SL, Brazil, Maranhão State: stream at the Anapurus municipality, 03°40'14"S, 43°07'10"W, 05 Feb 2017, Guimarães E. C. and Brito P. S.

Paratypes. All from Brazil, Maranhão State: CICCAA 00430, 15, 18.4–25.2 mm SL; CICCAA 00696, 15, 19.9–24.4 mm SL, CICCAA 00697, 16 (C&S) 19.3–24.5 mm SL; CICCAA 00698, 6, 1 (C&S) 22.0–20.4 mm SL; CICCAA 00750, 9, 20.0–25.3 mm SL; CPUFMA 171664, 15, 19.5–23.1 mm SL; UFRJ 11553, 6, 19.1–22.1 mm SL collected with holotype. CICCAA 00089, 1 (C&S) 25.2 mm SL, stream at Mata de Itamacaoca, Chapadinha municipality; 03°44'50"S, 43°19'21"W, 02 Apr. 2016, Ottoni F. P., Oliveira E., Nascimento I., Fernandes R., Carneiro V. leg. CICCAA 00431, 21, 15.3–19.8 mm SL, stream at the Anapurus municipality, 03°40'53"S, 43°07'23"W, 15 Jan. 2017, W; Aguiar R. leg. CICCAA 00881, 1, 29.4 mm SL, stream at Mata de Itamacaoca, Chapadinha municipality; 03°44'45"S, 45°19'15"W, 15 Jul. 2017, Campos D., Oliveira E., Viana S., Lopes M., Sousa R. leg. CICCAA 01563, 1, 21.6 mm SL, stream at Mata de Itamacaoca, Chapadinha municipality; 03°44'55"S 43°19'55"W, 19 Nov. 2017, Guimarães E. C., Brito P. S., Ottoni F. P., Lucas O., Sousa R. leg. CICCAA01654, 1, 26.9 mm SL, stream at the Anapurus municipality, 03°40'14"S, 43°07'10"W, 17 Jan. 2018, Guimarães E. C. and Brito P. S. leg. CICCAA 01382, 5, 22.7–27.2 mm SL, stream at Mata Fome, Barreirinhas municipality, 02°39'47"S, 42°48'16"W, 15 Jun., 2017, Guimarães E. C., Brito P. S., Ottoni F. P., Ferreira B. R. CICCAA 02008, 12 (C&S), 15.4–18.3 mm SL, stream at Mata Fome, Barreirinhas municipality; 02°39'47"S, 42°48'16"W, 15 Jun., 2017, Guimarães E. C., Brito P. S., Ottoni F. P., Ferreira B. R. leg.

Diagnosis (PAA). The new species *Hyphessobrycon piorskii* sp. n., promptly differs from most congeners except by species of *Hyphessobrycon sensu stricto* by the presence of a dark brown or black blotch on dorsal fin (vs. absence), no midlateral stripe on the body (vs. presence) and Weberian apparatus upward horizontal through dorsal margin of operculum (vs. downward).

The new species herein described differs from all of its congeners from *Hyphessobrycon sensu stricto*, with exception to *H. bentosi* and *H. hasemani*, by possessing an inconspicuous vertically elongated humeral spot [vs. approximately rounded humeral spot in *H. copelandi*, *H. erythrostigma*, *H. jackrobertsi*, *H. minor*, *H. pando*, *H. paepkei*, *H. pyrrhonotus*, *H. roseus*, *H. socolofi*, and *H. sweglesi*; humeral spot horizontally or posteriorly elongated in *H. epicharis*, *H. khardinae*, and *H. wernerii*; conspicuous humeral spot in *H. eques*, *H. haraldschultzi* Travassos, 1960, *H. micropterus*, *H. megalopterus*, *H. simulatus* and *H. takasei*; and absence of humeral spot in *H. compresus*, *H. dorsalis* Zarske, 2014, *H. georgettae*, *H. pulchripinnis*, and *H. rosaceus*].



Figure 1. *Hyphessobrycon piorskii* sp. n. **A** CICCAA 00695, holotype, 25.9 mm SL, Brazil: Maranhão State: Munim River basin **B** CICCAA 00881, paratype, 29.4 mm SL, Brazil: Maranhão State: Munim River basin (photographed by Felipe Ottoni).

The new species differs from *H. bentosi* by the absence of an extended and pointed dorsal and anal-fin tips (Figures 1, 2) [vs. extended and pointed dorsal and anal-fin tips]; and from *H. hasemani* by the dorsal-fin black spot shape, which is located approximately at the middle of the fin's depth, not reaching its tip [vs. extended along all the fin, reaching its tip in adults] and by presenting tri to unicuspid teeth in the inner row of premaxillary and dentary [vs. pentacuspid teeth].

Description. Morphometric data of holotype and paratypes are presented in Table 3. Body compressed, moderately deep, greatest body depth slightly anterior to dorsal-fin base. Body profile straight and downward directed from end of dorsal fin to adipose fin, straight or slightly convex between later point and origin of dorsal most procurent caudal-fin ray. Dorsal profile of head convex from upper lip to vertical through eye; predorsal profile of body roughly straight, dorsal-fin base slightly convex, posteroventrally inclined; ventral profile of head convex from lower jaw to pelvic-fin

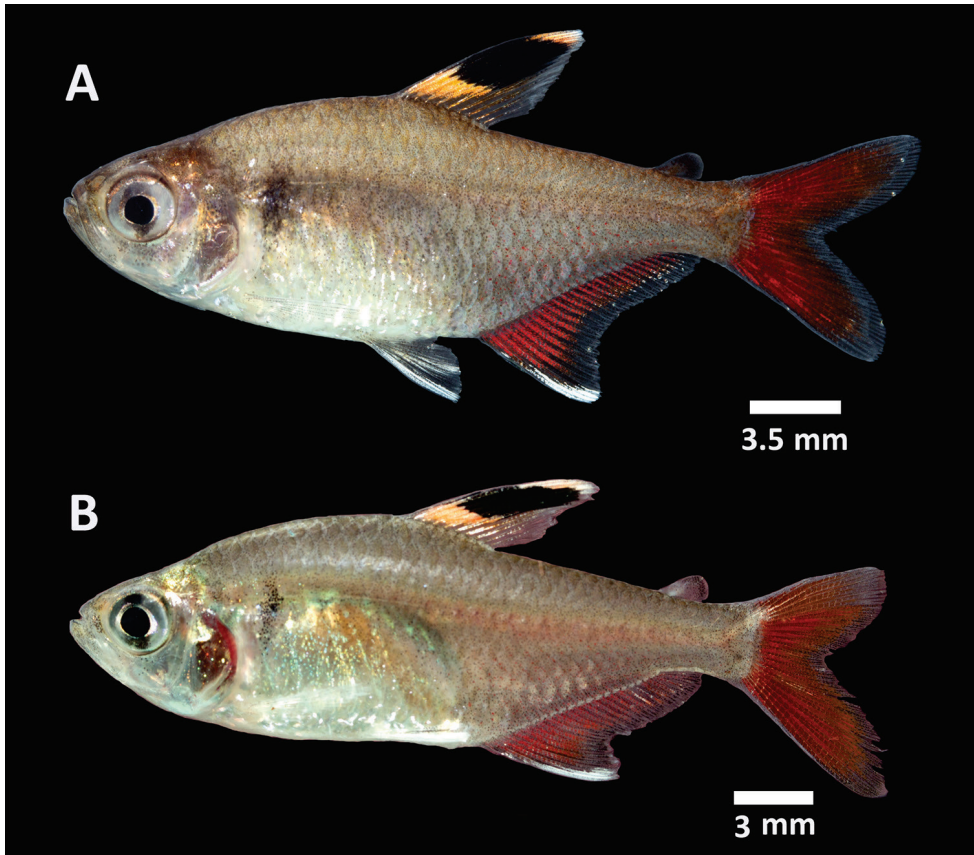


Figure 2. *Hyphessobrycon piorskii* sp. n. **A** CICCAA 00698, paratype, 26.9 mm SL, Brazil: Maranhão State: Munim River basin; living specimen photographed immediately after collection **B** CICCAA 00089, paratype, 25.2 mm SL, Brazil: Maranhão State: Munim River basin; living specimen photographed immediately after collection (photographed by Felipe Ottoni).

origin. Ventral profile of body straight or slightly convex from pelvic-fin origin to anal-fin origin; straight and posterodorsally slanted along anal-fin base; and slightly concave on caudal peduncle. Jaws equal, mouth terminal, anteroventral end of dentary protruding. Maxilla reaching vertical to anterior margin of pupil. Premaxillary teeth in two rows. Outer row with one tricuspid tooth; inner row with 6(6), 7(20) or 8(4) tricuspid teeth and one unicuspid tooth. Maxilla with 3(5), 5(24) or 6(1) tricuspid teeth. Dentary with five (21) or six (9) larger tricuspid teeth followed by one smaller tricuspid teeth 5(2), 6(6), 7(13), 8(5), 9(4) smaller unicuspid teeth (Figure 3). Scales cycloid, three to eight radii strongly marked, *circuli* well-marked anteriorly, weakly-marked posteriorly; lateral line incompletely pored, with 6(19), 7(62) or 8(13) perforated scales. Longitudinal scales series including lateral-line scales 31(9), 32(34), 33(26), 34(17) or 35(3). Longitudinal scales rows between dorsal-fin origin and lateral line 6(49) or 7(41). Horizontal scale

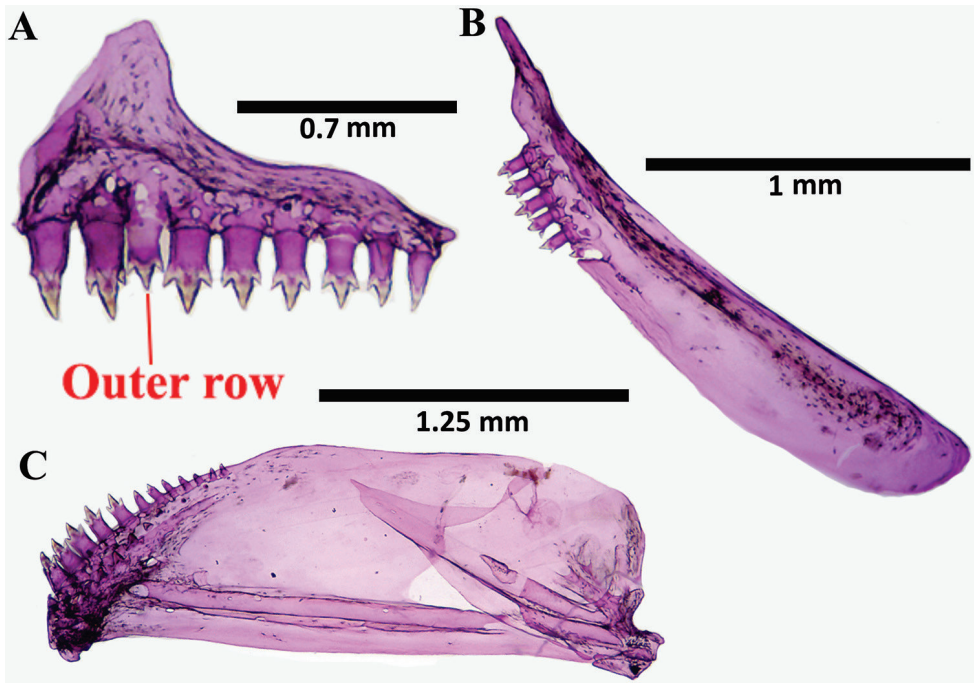


Figure 3. *Hyphessobrycon piorskii* sp. n. CICCAA 00697, 19.3 mm SL; jaw suspensory: **A** Premaxillary. **B** Maxilla **C** Dentary (Photographed by Erick Guimarães).

rows between lateral line and pelvic-fin origin 4(18) or 5(71). Scales in median series between tip of supraoccipital spine and dorsal-fin origin 8(6), 9(14), 10(7) or 11(3). Circumpeduncular scales 11(16), 12(38) or 13(11). Dorsal-fin rays i + 10(105) or ii + 10(18). First dorsal-fin pterygiophore main body located behind neural spine of 4th vertebrae. Adipose fin present. Anteriormost anal-fin pterygiophore inserting posterior to haemal spine of 11th vertebrae. Anal-fin ii+24(3), iii+24(87), ii-25(32) or iii+25(1). Anterior anal-fin margin slightly convex, with anteriormost rays more elongate and slightly more thickened than remaining rays, forming a distinct lobe. Remaining rays smaller with straight distal margin. Anal-fin rays with a sexually dimorphic pattern, which are absent in females (Figure 4). Pectoral fin-rays 12(122) or 13(1) total rays. Tip of pectoral fin usually reaching vertical through pelvic-fin origin. Pelvic-fin rays 8(125) total rays. Pelvic-fin rays with a sexually dimorphic pattern, which are absent in females (Fig. 5). Caudal fin forked, upper and lower lobes similar in size. Principal caudal-fin rays 10+9(121), 10+10(7) or 11+10(17); dorsal procurrent rays 7(1), 9(13), 10(13) or 11(3) and ventral procurrent rays 6(1), 7(8), 8(12) or 9(9). Branchiostegal rays 4(30). First gill arch with 1(1), 2(29) hypobranchial, 11(1), 12(28) or 13(1) ceratobranchial, 1(30) on cartilage between ceratobranchial and epibranchial, and 5(1) or 6(16) epibranchial gill-rakers. Supraneurals 3(2) 4(23) or 5(5). Total vertebrae 29(30).

Color in alcohol Figure 1. Ground coloration light yellowish brown. Humeral region with one inconspicuous vertically elongated spot; more intensely pigmented on its central portion. Flank with chromatophores homogeneously scattered, more concentrated on posterior region to humeral spot, posterior region of dorsal-fin base origin and below mid-portion of trunk, between anal-fin origin and caudal peduncle. Ventral region lacking dark brown chromatophores. Dark brown chromatophores present on head and more concentrated on dorsal portion, becoming sparser on cheek and preopercular regions.

Dorsal fin ground coloration hyaline, with a conspicuous black or dark brown spot located on anterior portion of fin, reaching about sixth ray, approximately between half to two thirds of fin depth. Anal and caudal fins hyaline. Caudal fin with a darker, usually dark brown, posterior margin and on its base. Adipose fin hyaline to light brown, with dark brown or black chromatophores more concentrated on its dorsal portion, depending on the state of preservation of the specimen. Pectoral and pelvic fins hyaline; pelvic fin with variable amounts dark brown pigmentation remaining depending on the state of preservation of the specimen.

Color in life (Figure 2). Pattern similar to coloration of preserved specimens. Ground coloration light yellowish brown to grey, with a reddish-brown pigmentation on vertebrae region, and usually with red chromatophores. Ventral region anterior to anal-fin origin lighter. Humeral spot inconspicuously dark brown or black. Head with same coloration as body, and ventrally lighter.

Conspicuous black spot on dorsal-fin, with yellow or orange pigmentation on dorsal and ventral margins of spot; yellow or orange pigmentation lighter and less evident on dorsal margin, reaching half to two thirds of the spot length and extending to the tip of fin; yellow or orange pigmentation darker and more developed at ventral margin of the spot, reaching entire spot base length, not extended to dorsal fin-base. Rest of dorsal fin hyaline. Anal-fin base with red pigmentation, with different degrees of intensity, with milk white pigmentation on anterior tip of anal fin, which could be extended through entire anterior margin, reaching between second to fourth rays. Posterior margin of anal fin with an inconspicuous dark brown pigmentation. Adipose fin light brown to hyaline at base, with red to black pigmentation at tip. Pectoral and pelvic fins hyaline, with some sparser dark brown chromatophores, more concentrated at pelvic fin base. First ray of pelvic fin with a white pigmentation. Caudal fin with red pigmentation on almost fin, with an inconspicuous light brown, reddish brown or dark brown margin.

Sexual dimorphism. Mature males have hooks on anal-fin and pelvic-fin rays. Hooks absent on females. Anal-fin presenting hooks from 3rd, 4th or 5th rays through last ray. Number of hooks variable, increasing from the first ones to the last rays. Pelvic fin presenting 3rd and 4th rays with 5 smaller hooks (Figures 4, 5).

DNA-based identification. After trimming sequence ends with poor base call quality, the final alignment yielded 446 base pairs with 154 variable sites, and 22 haplotypes. The magnitude of sequence divergence clearly demonstrates the exist-

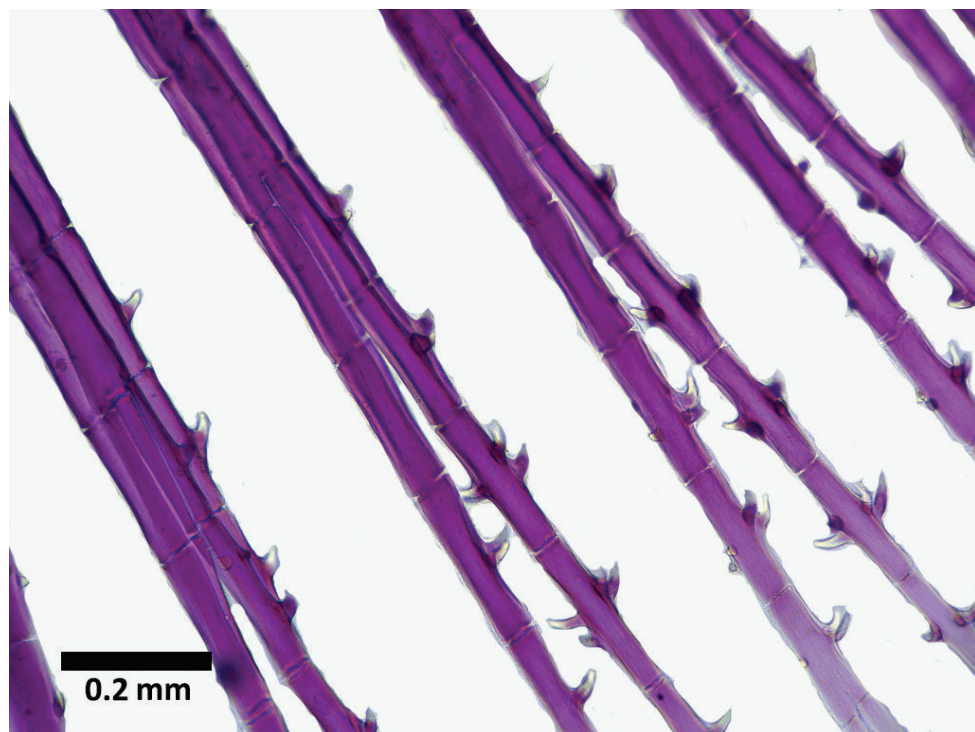


Figure 4. *Hyphessobrycon piorskii* sp. n. CICCAA 00697, male, 19.3 mm SL, bony hooks on anal fin (photographed by Erick Guimarães).

ence of a new species of *Hyphessobrycon* inhabiting the Munim and Preguiças river basins in Maranhão State. Average genetic distances were 14.2%, with the highest values between *H. pyrrhonotus* and *H. epicharis* (19.2%), while the lowest value (2.7%) was between *H. epicharis* and *H. sweglesi* (Table 1). *Hyphessobrycon piorskii* sp. n. has 17% sequence divergent, on average, from the other taxa, with a minimum distance with *H. eques* (13.9%) and a maximum with *H. rosaceus* (18.4%) (Table 2).

Other evidence for the new species is that *H. piorskii* sp. n. formed a single and exclusive clade with maximum posterior probability support (posterior probability = 1) in the Bayesian phylogenetic tree (Figure 7). Furthermore, *H. piorskii* sp. n. clade is located within the *Hyphessobrycon* s. str. group with high support of posterior probability (0.94). *Hyphessobrycon piorskii* sp. n. was recovered as the sister-group of the clade including *H. bentosi*, *H. socolofi*, *H. megalopterus*, *H. erythrostigma* and *H. pyrrhonotus*, with branch support of posterior probability value of 0.55. *Pristella maxillaris* and *Moenkhausia hemigrammoides* formed a clade (posterior probability value = 0.86), and it was recovered as the sister-clade of the *Hyphessobrycon* s. str. group (posterior probability value = 0.6).

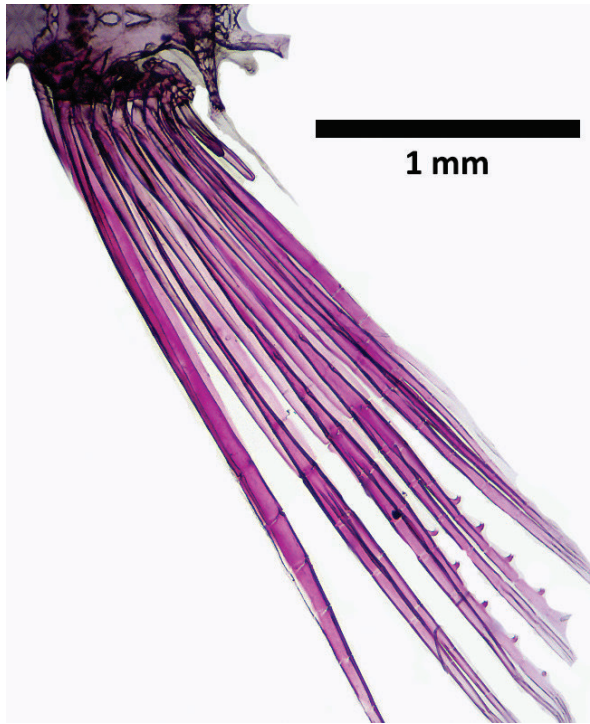


Figure 5. *Hyphessobrycon piorskii* sp. n. CICCAA 00697, male, 19.3 mm SL, bony hooks on pelvic fin (photographed by Erick Guimarães).

Geographical distribution. *Hyphessobrycon piorskii* sp. n. is presently known only from the upper Munim and Preguiças river basins, Maranhão State, northeastern Brazil (Figure 7).

Ecological notes. *Hyphessobrycon piorskii* sp.n. lives in shallow well-oxygenated streams with transparent waters flowing over different types of substrates (Figure 8). The streams where *H. piorskii* sp. n. specimens were collected varied from 0.90 to 10 meters wide, with a maximum depth of 1.60 meters. They possessed moderate water currents (0.1–0.7 m/s), with clear, sandy substrates with pebbles, mud, leaf litter, and submerged logs, often also presenting aquatic macrophytes. *Hyphessobrycon piorskii* sp. n. was found near shore among aquatic vegetation, tree roots and fallen logs. Other species found at both sites were *Anablepsoides vieirai* Nielsen, 2016, *Apistogramma piauiensis* Kullander, 1980, *Astyanax* sp., *Cichlasoma* cf. *zarskei*, *Copella arnoldi* (Regan, 1912), *Crenicichla brasiliensis* (Bloch, 1792), *Hoplias malabaricus* (Bloch, 1794), *Megalechis thoracata* (Valenciennes, 1840), *Nannostomus beckfordi* Günther, 1872, and *Synbranchus marmoratus* Bloch, 1795. Gut contents of C&S specimens contained algae and disarticulated arthropod remains.

Etymology. The name *piorskii* honors the ichthyologist Nivaldo Magalhães Piorski for his contributions to the ichthyologic knowledge of the Maranhão State.

Table 2. Kimura-2 parameters pairwise genetic distances among species. Species names in the upper columns are abbreviated as follows: *H. piorskii* (Hpio), *H. flammeus* (Hfla), *H. anisitsi* (Hani), *H. socolofi* (Hsoc), *H. copelandi* (Hcop), *H. bentosi* (Hben), *H. megalopterus* (Hmeg), *H. eques* (Hequ), *H. erythrostigma* (Hery), *H. pyrrhonotus* (Hpyr), *H. rosaceus* (Hros), *H. sweglesi* (Hswe), *H. epicharis* (Hepi), *M. hemigrammoides* (Mhem), and *P. maxillaris* (Pmax).

Species	Hpio	Hfla	Hani	Hsoc	Hcop	Hben	Hmeg	Hequ	Hery	Hpyr	Hros	Hswe	Hepi	Mhem
Hfla	0.190	-												
Hani	0.194	0.165	-											
Hsoc	0.199	0.193	0.168	-										
Hcop	0.158	0.206	0.162	0.216	-									
Hben	0.207	0.204	0.173	0.008	0.221	-								
Hmeg	0.195	0.209	0.180	0.087	0.213	0.086	-							
Hequ	0.161	0.205	0.186	0.190	0.102	0.194	0.199	-						
Hery	0.196	0.213	0.182	0.114	0.191	0.117	0.131	0.174	-					
Hpyr	0.183	0.206	0.166	0.101	0.191	0.103	0.117	0.181	0.032	-				
Hros	0.218	0.212	0.205	0.224	0.202	0.227	0.204	0.195	0.219	0.221	-			
Hswe	0.205	0.187	0.195	0.224	0.198	0.229	0.192	0.183	0.216	0.211	0.073	-		
Hepi	0.199	0.190	0.198	0.221	0.198	0.226	0.199	0.183	0.233	0.231	0.089	0.028	-	
Mhem	0.185	0.204	0.178	0.214	0.216	0.219	0.234	0.205	0.233	0.222	0.200	0.204	0.208	-
Pmax	0.223	0.212	0.197	0.203	0.219	0.207	0.218	0.200	0.230	0.239	0.202	0.187	0.181	0.169

Table 3. Morphometric data (N = 95) for the holotype and paratypes of *Hyphessobrycon piorskii* sp. n. from the Munim River basin and Preguiças River basin. Abbreviations: SD: Standard deviation.

	Holotype	Paratypes	Mean	SD
Standard length	25.9	18–29.4	20.8	–
Percentages of standard length				
Depth at dorsal-fin origin (body depth)	35.9	28.9–39.4	33.4	1.9
Snout to dorsal-fin origin	49.8	44.2–56.5	52.5	2.1
Snout to pectoral-fin origin	29.1	26.0–35.0	30.8	2.3
Snout to pelvic-fin origin	47.5	39.1–52.2	47.5	1.9
Snout to anal-fin origin	61.9	57.4–66.6	61.7	1.8
Caudal peduncle depth	11.8	9.1–14.1	11.4	0.9
Caudal peduncle length	12.2	8.1–13.6	10.2	1.1
Pectoral-fin length	20.4	16.8–23.7	20.8	1.6
Pelvic-fin length	18.1	13.3–20.4	17.1	1.5
Dorsal-fin base length	15.5	12.9–18.3	15.7	1.2
Dorsal-fin height	28.5	22.1–34.3	29.9	2.4
Anal-fin base length	29.4	26.3–33.9	30.3	1.4
Eye to dorsal-fin origin	35.2	33.6–39.4	36.4	1.4
Dorsal-fin origin to caudal-fin base	50.7	44.9–57.3	51.4	2.3
Head length	26.3	24.2–33.4	29.3	2.1
Percentages of head length				
Horizontal eye diameter	42.8	33.4–43.8	38.2	2.3
Snout length	22.0	16.9–24.4	20.2	1.7
Least interorbital width	25.7	16.4–27.0	20.4	2.2
Upper jaw length	39.6	32.8–41.7	38.1	2.2

Discussion

Despite *Hyphessobrycon*, as defined today, being a non-monophyletic group (Mirande 2010, Oliveira et al. 2011, Carvalho et al. 2017, Ohara et al. 2017, Moreira and Lima 2017), a few putative groups within the genus were proposed in the literature. One such case is the *Hyphessobrycon sensu stricto* as defined by Carvalho (2011) and Cavalho and Malabarba (2015). According to those authors, this group is composed by approximately 25 species.

Among the species considered by Weitzman and Palmer (1997) as possibly related to the “rosy tetra clade”, only *H. hasemani* and *H. pulchripinnis* were considered to belong to *Hyphessobrycon sensu stricto* (Carvalho 2011, Carvalho and Malabarba 2015). *Pristella maxillaris* (Ulrey, 1894) is the sister-group of the *Hyphessobrycon sensu stricto* (Carvalho 2011), and corroborated in our analysis (Figure 6).

Hyphessobrycon piorskii sp. n. exhibits all the diagnostic features that define *Hyphessobrycon sensu stricto* (see introduction and diagnosis section). The new species differs from the other possible species of this assemblage, which also occur near Maranhão (e.g., lower Amazon River basin, Guamá River basin, and São Francisco River basin), such as *H. bentosi*, *H. copelandi*, *H. eques*, *H. dorsalis*, *H. hasemani*, *H. haraldschultzi*, *H. micropterus*, and *H. werneri*, by a set of features listed below.

Hyphessobrycon piorskii sp. n. possesses an inconspicuous vertically elongated humeral spot, distinguishing it from all the species cited above, except for *H. bentosi* and *H. hasemani* (see morphological diagnosis section). The shape of the dorsal-fin spot is also useful to distinguish *H. piorskii* sp. n. from *H. eques*, *H. hasemani* and *H. micropterus*, which possess dorsal fin spot vertically extended, reaching the tip of the fin, while in *H. piorskii* sp. n. the black spot of dorsal fin never reaches the tip of the fin. The new species also differs from *H. eques* by the color pattern of the anal fin: *H. eques* possess a conspicuous black anal-fin margin on preserved species, while *H. piorskii* sp. n. does not exhibit this feature at the anal fin.

The number of teeth cusps was also revealed to be a useful feature for species discrimination. *Hyphessobrycon piorskii* sp. n. possess all of its teeth with one to three cusps (never pentacuspoid), while *H. eques* possess pentacuspoid teeth on the maxillary and inner row of premaxillary, and *H. copelandi* and *H. hasemani* on the dentary and inner row of the premaxilla (see Lima et al. 2013). The new species differs from *H. bentosi* by not having extended and pointed dorsal and anal-fin tips and by having bone hooks on anal-fin rays of mature males (Figure 3). The dorsal and anal fins of *H. bentosi* have pointed and extended tips, and it has not bony hooks on anal-fin rays (see Carvalho 2011, Zarske 2014). *Hyphessobrycon copelandi* possesses only ten teeth on the dentary, and dorsal-fin black spot reaching to the posterior margin of the fin (see Lima et al. 2013), while *H. piorskii* sp. n. possesses 11–15 teeth on dentary, and dorsal-fin black spot restricted to the anterior half of the fin's length. In addition, *Hyphessobrycon piorskii* sp. n. is easily distinguished from the sister-species of the clade *Hyphessobrycon sensu stricto*, *P. maxillaris* and *M. hemigrammoides*, by the absence of a black oblique stripe or band on the anterior portion of the anal fin (Figures 1, 2) [vs. presence (Carvalho et al. 2017, figure 7; pers. obs.)].

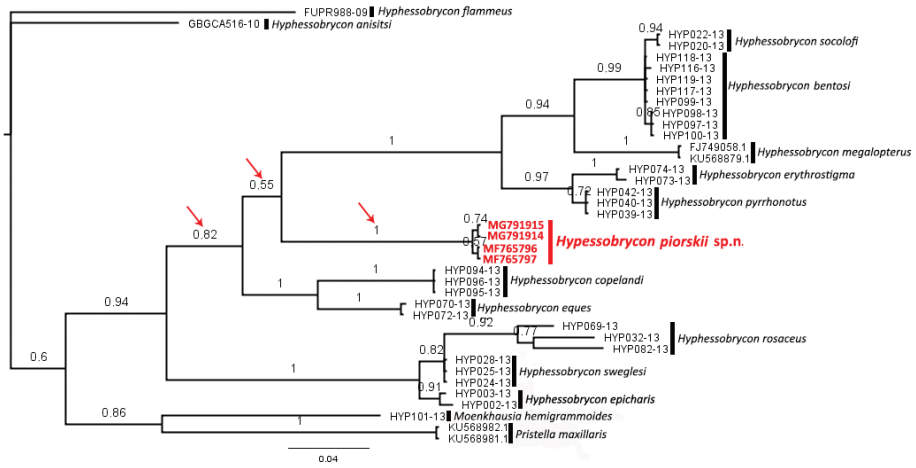


Figure 6. Bayesian phylogenetic tree including *Hyphessobrycon piorskii* sp. n. (in red) and other congeners. Number above branches are posterior probability values.

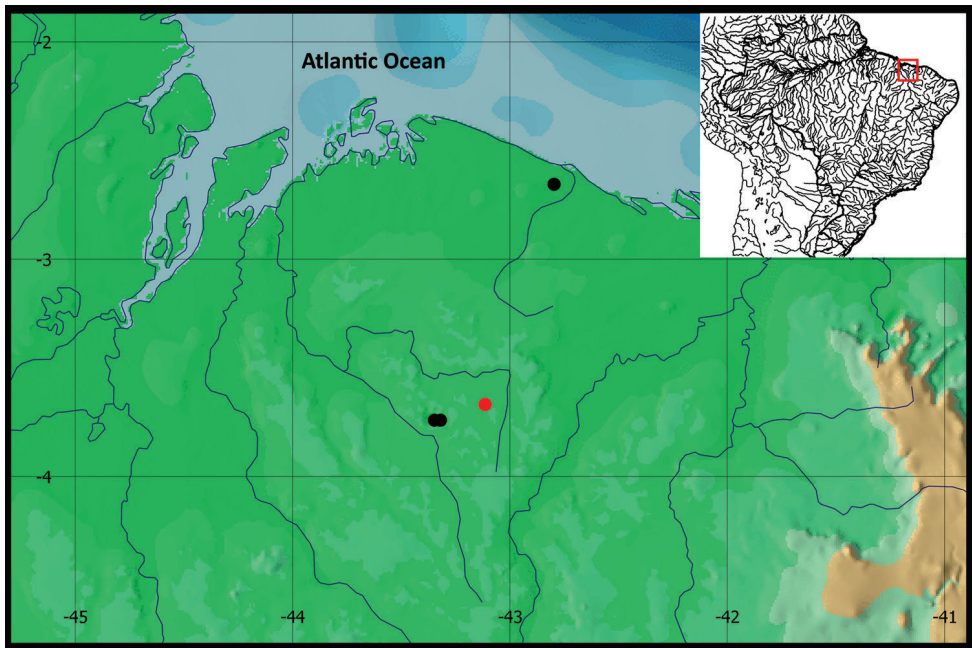


Figure 7. Geographical distribution of *Hyphessobrycon piorskii* sp. n. Red circle denote Holotype and black circle denote paratypes.

The description of *H. piorskii* sp. n. was based on morphological and molecular species delimitation methods, using the congruence of multiple operational criteria for determining species boundaries. As mentioned earlier, evidence corroborated from



Figure 8. Collecting sites of *Hyphessobrycon piorskii* sp. n. **A** stream at the Anapurus municipality **B** stream at Mata de Itamacaoca **C** stream at Mata de Itamacaoca **D** stream at Mata Fome, Barreirinhas municipality (photographed by Felipe Ottoni).

multiple operational criteria is considered to produce stronger hypotheses of lineage divergence (de Queiroz 2007, Goldstein and Desalle 2010), thus congruent to the proposal for an integrative taxonomy (Goldstein and Desalle 2010, Padial et al. 2010). The morphological criteria (PAA) distinguished the new species from all of the other congeners by unambiguous character states (see diagnosis). The DNA barcoding (DBC) criteria also revealed that *H. piorskii* sp. n. is a new species with an average sequence divergence of 17% from the other taxa (Table 2). In addition, *H. piorskii* sp. n. is placed in an exclusive and highly supported clade in the Bayesian tree (Figure 6). Haplotypes clustered as an exclusive and high supported group, with geographical concordance area is evidence of lineage divergence, therefore a good and strong evidence for delimit species, and consequently describe them (Wiens and Penkrot 2002, Costa et al. 2014).

Our Bayesian tree also recovered *H. piorskii* sp. n. within the *Hyphessobrycon sensu stricto* group with high support (posterior probability = 0.94), which fits the morphological evidence, since *H. piorskii* sp. n. exhibits the three main diagnostic character states of the group (see introduction and diagnosis section). *Hyphessobrycon piorskii* sp. n. was recovered as the sister-group of the clade including *H. bentosi*, *H. socolofi*, *H. megalopterus*, *H. erythrostigma*, and *H. pyrrhonotus*, however this relationship was supported by a lower support value (posterior probability value = 0.55). Only posterior probability values about or higher than 0.95 are considered as statistically significant

(Alfaro and Holder 2006). Therefore, any discussion about the relationship and supposed shared morphological features between *H. piorskii* sp. n. and this clade is speculative (Figure 7). To a better understanding of the internal relationships of the group, an analysis including more genes, especially from nuclear genome, is highly recommended. However, this was not the scope of the present paper. *Pristella maxillaris* and *Moenkhausia hemigrammoides* were recovered as the sister-clade of the *Hyphessobrycon sensu stricto* group, corroborating partially the results of Carvalho et al. (2011) and Carvalho and Malabarba (2015), who argue that *P. maxillaris* is the sister-clade of the *Hyphessobrycon sensu stricto* group.

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APÊNDICE V: Artigo Publicado

Título: *Roeboides margareteae* Lucena, 2003

Autores: Pâmella Silva De Brito, Erick Cristofore Guimarães, Nivaldo Magalhães Piorski, Felipe Polivanov Ottoni

Revista: Boletim da Sociedade Brasileira de Ictiologia

Qualis: C – Biodiversidade

PEIXE DA VEZ

Roeboides margaretae Lucena, 2003

Pâmella Silva De Brito¹, Erick Cristofore Guimarães², Nivaldo Magalhães Piorski^{1,2}, Felipe Polivanov Ottoni^{1,2}



Nomes populares. Dentudo, Cacunda, Saicanga.

Localidade tipo. Sistema do Rio Pindaré-Mearim, Lago de Viana, Maranhão, Brasil (Lucena, 2003).

Etimologia. Denominado *margaretae* em homenagem à pesquisadora Zilda Margarete Lucena.

Informações gerais. *Roeboides margaretae* foi descrito por Lucena em 2003. Pertence a ordem Characiformes, família Characidae, subfamília Characinae.

Identificação. Os indivíduos dessa espécie possuem pequeno-médio porte, com comprimento padrão máximo conhecido de 184,7 mm. É membro do “Grupo-microlepis” que é caracterizado principalmente: pela presença de um elevado número de escamas perfuradas na linha lateral (mais de 88), presença de 7 à 10 fileiras de escamas que formam uma bainha em quase toda extensão da base da nadadeira anal e limite anterior da abertura entre os ramos posteriores do paresfenóide localizado bem à frente da vertical que passa pelo limite dos ossos basioccipital e pró-ótico (Lucena, 2003). Difere de todos os seus congêneres do “Grupo-microlepis” por apresentar 39 vértebras totais. Para maiores detalhes e informações relacionadas à morfologia, taxonomia e estados de caracteres diagnósticos, ver Lucena (2003).

Biologia. Ocorre em baías e remansos de rios e córregos. Possui dieta onívora, alimentando-se de escamas de peixes, insetos e secundariamente plantas

(Guimarães, 2018, comunicação pessoal – oral)

Distribuição. *Roeboides margaretae* ocorre nas bacias dos rios Mearim, Itapecuru, Munim e Parnaíba, nos Estados do Maranhão e Piauí, nordeste do Brasil (Barros *et al.*, 2011, Eschmeyer *et al.*, 2018).

Conservação. *Roeboides margaretae* não encontra-se ameaçada de extinção segundo a lista recente de espécies ameaçadas (Brasil, 2014).

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APÊNDICE VI: Artigo Publicado

Título: Hyphessobrycon piorskii Guimarães, Brito, Feitosa, Carvalho- Costa, Ottoni, 2018

Autores: Erick Cristofore Guimarães, Pâmella Silva De Brito, Leonardo Manir Feitosa, Luís Fernando Carvalho-Costa, Felipe Polivanov Ottoni

Revista: Boletim da Sociedade Brasileira de Ictiologia

Qualis: C – Biodiversidade

PEIXE DA VEZ

Hyphessobrycon piorskii Guimarães, Brito, Feitosa, Carvalho-Costa, Ottoni, 2018

Erick Cristofore Guimarães¹, Pâmella Silva de Brito², Leonardo Manir Feitosa³, Luís Fernando Carvalho-Costa⁴, Felipe Polivanov Ottoni^{1,2}



Nomes populares. Mato-Grosso, Piaba, Piabinha.

Localidade tipo. Igarapé na entrada do município de Anapurus, Bacia do Rio Munim, estado do Maranhão, Brasil.

Etimologia. O nome *piorskii* homenageia o professor Nivaldo Magalhães Piorski por suas contribuições ao conhecimento da ictiofauna do estado do Maranhão.

Informações gerais. *Hyphessobrycon piorskii* foi descrito por Guimarães *et al.*, 2018 e pertence a ordem Characiformes, família Characidae, subfamília Pristellinae.

Identificação. Os indivíduos dessa espécie possuem pequeno porte, com comprimento padrão máximo conhecido de 29,4 mm CP. É membro do grupo de espécies *Hyphessobrycon sensu stricto* que é caracterizado principalmente pela presença de uma mancha marrom escuro ou preta na nadadeira dorsal e ausência de faixa na região mediana do flanco (Carvalho & Malabarba, 2015). Difere de todos os seus congêneres de *Hyphessobrycon sensu stricto* com exceção de *H. bentosi* Durbin 1908 e *H. hasemani* Fowler, 1913 principalmente por possuir mancha humeral inconspícua, verticalmente alongada. A espécie pode ser diferenciada de *H. bentosi* principalmente pela ausência de uma extensa e pontiaguda nadadeira dorsal e anal e de *H. hasemani* principalmente pela forma da mancha negra da nadadeira dorsal, localizada aproximadamente no meio da nadadeira, não atingindo sua ponta. Para maiores detalhes e informações relacionadas a morfologia e estados de caracteres diagnósticos, ver Guimarães *et al.* (2018).

Biologia. Ocorrem em riachos preservados de águas claras, rasas, bem oxigenadas, que apresentam macrófitas aquáticas e sobre diferentes tipos de substratos claros, arenosos com seixos, lama, folha liteira e troncos submersos. Esses ambientes variam de 0,90 a 10 metros de largura, com profundidade

máxima de 1,60 metros, corrente d'água moderada (0,1-0,7 m / s). Aparentemente, a espécie possui hábito alimentar onívoro (Guimarães *et al.*, 2018), e ocupa, principalmente, a região central da coluna d'água. Possui dimorfismo sexual, com machos maduros apresentando pequenos ganchos ósseos nas nadadeiras anal e pélvicas, enquanto as fêmeas não apresentam esses ganchos ósseos.

Distribuição. *H. piorskii* ocorre nas bacias do alto Rio Munim e Preguiças, Estado do Maranhão, nordeste do Brasil.

Conservação. A espécie possui registro para o Parque Nacional dos Lençóis Maranhenses (Unidade de Conservação Federal de Proteção Integral). No entanto, sua restrita distribuição geográfica (Guimarães *et al.*, 2018) aliada a perda de seus habitats, oriunda de efeitos antrópicos, impõe riscos à preservação da espécie.

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APÊNDICE VII: Artigo Publicado

Título: Taxonomic status of *Aphyocharax avary* Fowler, 1913, *Aphyocharax pusillus* Günther, 1868 and *Chirodon alburnus* Günther, 1869 (Characiformes, Characidae)

Autores: Pâmella Silva de Brito, Erick Cristofore Guimarães, Axel Makay Katz, Nivaldo Magalhães Piorski, Felipe Polivanov Ottoni

Revista: Zoosystematics and Evolution

Qualis: B2 – Biodiversidade

Taxonomic status of *Aphyocharax avary* Fowler, 1913, *Aphyocharax pusillus* Günther, 1868 and *Chirodon alburnus* Günther, 1869 (Characiformes, Characidae)

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Abstract

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The obscure taxonomic histories of three species of *Aphyocharax* (*A. alburnus*, *A. avary* and *A. pusillus*) are revised, based on both morphological and literature data. *Aphyocharax avary* is resurrected as a valid species and removed from synonymy with *A. alburnus*. Based on examinations of type specimens, *A. alburnus* is considered a junior synonym of *A. pusillus*.

Key Words

Aphyocharacinae
Characoids
junior synonym
taxonomy

Introduction

Aphyocharax Günther, 1868, is a genus of small-sized characids, no larger than 80 mm standard length (Souza-Lima 2003), occurring in most river basins in the Neotropical region: the Orinoco, Amazon, and La Plata River systems (Taphorn and Thomerson 1991, Tagliacollo et al. 2012). According to Tagliacollo et al. (2012),

Froese and Pauly (2018) and Eschmeyer et al. (2018), the genus comprises 11 valid species: *Aphyocharax agassizii* (Steindachner, 1882), *A. alburnus* (Günther, 1869), *A. anisitsi* Eigenmann & Kennedy, 1903, *A. colifax* Taphorn & Thomerson, 1991, *A. dentatus* Eigenmann & Kennedy, 1903, *A. erythrurus* Eigenmann, 1912, *A. gracilis* Fowler, 1940, *A. nattereri* (Steindachner, 1882), *A. pusillus* Günther, 1868 (the type species of the genus), *A. rathbuni*

Eigenmann, 1907, and *A. yekwanae* Willink, Chernoff & Machado-Allison, 2003. However, some authors (e.g., Souza-Lima 2007, Ferreira et al. 2011, Lima et al. 2013) consider *A. avary* Fowler, 1913, as a 12th valid species. *Aphyocharax avary* was described by Fowler (1913) based on a single specimen from the “Madeira River, about 200 miles east of Long. 62°20’W., Brazil”. Fowler (1940) later considered it a synonym of *A. alburnus*. That taxonomic decision was based on a supposed morphological colour pattern variation and the number of teeth of those species – and influenced by their confusing taxonomic histories, principally the work published by Eigenmann (1915). Géry (1977) considered *A. avary* a valid species and included it in his species identification key of the genus. More recently, Souza-Lima (2003), following the taxonomic decision of Fowler (1940), also considered it a synonym of *A. alburnus*. Shortly afterwards, however, Souza-Lima (2007) considered *A. avary* to be a valid species. Tagliacollo et al. (2012) did not consider *A. avary* as one of the 11 valid species of the genus, although those authors did not specify which species they would consider it a synonym of; we presume that they again considered it a junior synonym of *A. alburnus*.

Aphyocharax pusillus was described by Günther (1868) based on three specimens from “Huallaga and Xeberos” [Amazon River Basin, Peru] (Souza-Lima 2003, 2007, Eschmeyer et al. 2018). Günther described the genus *Aphyocharax* in that same work, comprising only *A. pusillus*, which could be distinguished from *Chirodon* mainly by the presence of maxillary teeth (vs. their absence in *Chirodon*). Just one year later, Günther (1869) described *Chirodon alburnus* (currently a species of *Aphyocharax*) based on four specimens from the Peruvian Amazon, without providing a more precise and specific locality (Souza-Lima 2003, 2007, Eschmeyer et al. 2018), and did not detect maxillary teeth. Eigenmann (1915) re-described *Chirodon alburnus* without examining the type material, repeating the briefly informative description of the species provided by Günther (1869). Eigenmann (1915) examined five new lots from several distant localities, and characterized the species as possessing a humeral blotch and “maxillary with ten to sixteen teeth on over half the length of the maxillary” – character traits never before proposed for that species. Those specimens examined by Eigenmann probably corresponded to another species. The confusion caused by Eigenmann was followed by subsequent studies of the genus (e.g. Taphorn and Thomerson 1991, Willink et al. 2003).

Some authors who have recently described new species of *Aphyocharax*, or proposed phylogenetic relationships for the group, have overlooked the type locality of *A. alburnus* and examined and included material solely from Venezuelan river drainages (e.g., Taphorn and Thomerson 1991, Willink et al. 2003, Tagliacollo et al. 2012).

The aim of the present paper was to untangle the confusing taxonomic histories of those three species names, clarify their taxonomic statuses, and present, for the first time, the morphological features of their type specimens.

We also provide a diagnosis for the species considered herein as valid, based on the examinations of type materials, information from the original descriptions, and the literature. The resolution of this confusing taxonomic history, the description of some morphological features of the type materials, and determinations of which of the three species are valid, will be important to solving taxonomical incongruities in the literature related to the genus and to enabling descriptions of new species of *Aphyocharax*. According to Souza-Lima (2007), there are at least four undescribed species, and the taxonomic identifications of several populations are still inaccurate (e.g. Lima et al. 2013, Ohara et al. 2017).

Materials and methods

Measurements and counts were made according to Fink and Weitzman (1974), except for the perforated lateral line scales (which are interrupted) and the last scale on caudal-fin base (Y) which is counted separately from the other perforated scales (X), following the formula (X + Y). Internal counts, as well as some fins counts, were made only on radiograph images. The four modified vertebrae that constitute the Weberian apparatus were not included in the vertebrae counts, and the fused PU1 + U1 was considered a single element. Osteological nomenclature follows Weitzman (1962). C&S means cleared and stained, prepared according to Taylor and Van Dyke (1985). The materials herein examined are deposited in the following institutions: Academy of Natural Sciences of Philadelphia (ANSP), California Academy of Sciences, San Francisco, California, U.S.A. (CAS), Coleção Ictiológica do Centro de Ciências Agrárias e Ambientais da Universidade Federal do Maranhão (CICCAA), Coleção Ictiológica do Instituto de Biologia da Universidade Federal do Rio de Janeiro (UFRJ), British Museum of Natural History (BMNH) and Field Museum of Natural History (FNMH), and the Information about *Aphyocharax* was based on both examined material and the literature (e.g., Günther 1868, 1869, Fowler 1940, Eigenmann 1915, Géry 1977, Taphorn and Thomerson 1991, Souza-Lima 2003, 2007, Willink et al. 2003, Tagliacollo et al. 2012, Eschmeyer et al. 2018, Froese and Pauly 2018).

Taxonomy

Aphyocharax pusillus Günther, 1868

Aphyocharax pusillus Günther, 1868: 480. Type locality: Huallaga and Xeberos [Amazon River Basin, Peru]. Syntypes: (1) BMNH 1867.6.13.46, (2) BMNH 1867.6.13.58-59.

Chirodon alburnus Günther, 1869:424: Type locality: Peruvian Amazons [Amazon River Basin, Peru]. Lectotype: BMNH 1869.5.21.10; Paralectotypes: (3) BMNH 1869.5.21.11-13. **New synonym.**

Material examined. BMNH 1867.6.13.46, 1 (Syntype), Huallaga and Xeberos [Amazon River Basin, Peru], Mr. Bartlett. BMNH 1867.6.13.58-59, 2 (Syntypes), Huallaga



Figure 1. Syntypes of *Aphyocharax pusillus*: BMNH 1867.6.13.58-59. Photographed by Kevin Webb.



Figure 2. Lectotype of *Aphyocharax alburnus*: BMNH 1869.5.21.10. Photographed by Harry Taylor.

Table 1. Meristic data of *Chirodon alburnus* and *Aphyocharax pusillus*.

Measurements	BMNH 1867.6.13.46 <i>A. pusillus</i>	BMNH 1867.6.13.58-59 <i>A. pusillus</i>	BMNH 1869.5.21.10 <i>C. alburnus</i>	BMNH 1869.5.21.11-13 <i>C. alburnus</i>
Pored lateral-line scales	11+1	11–12+1	11+1	11+1
Longitudinal scales	36	36–38	37	37
Transverse scales	11	10–11	11	11
Dorsal-fin rays	10	10–11	11	10–11
Pectoral fin-rays	10	10–11	11	11
Pelvic-fin rays	7	7	7	7
Anal-fin rays	19	18–19	18	17–18
Premaxillary teeth	6	7	7	7
Maxillary teeth	8	8	8	7–8
Dentary teeth	15	16–18	16	15–18
Vertebrae	34	31–33	33	32–33

and Xeberos [Amazon River Basin, Peru], Mr. Bartlett. BMNH 1869.5.21.10, 1 (Lectotype of *Chirodon alburnus*), [Amazon River, Peru]. BMNH 1869.5.21.11-13, 3 (Paralectotypes of *Chirodon alburnus*), [Amazon River, Peru].

Diagnosis. *Aphyocharax pusillus* differs from all of its congeners, except *A. avary*, by having black or dark brown middle caudal-fin rays (Figs 1–3; Günther 1869, fig. 2). *Aphyocharax pusillus* is distinguished from *A. avary* by having fewer maxillary teeth, spread along the proximal half of the bone (Fig. 4B–G) [vs. more maxillary teeth spread along 2/3 of the maxillary extension (Fig. 4A)].

Morphological notes. Meristic data of the type specimens are presented in Table 1. Body shape generally fusiform, slightly elongate, greatest body depth slightly anterior to dorsal-fin base. Dorsal body profile straight or slightly convex from snout to vertical through anterior nostrils; straight or slightly convex from posterior nostrils to tip of supraoccipital bone; straight or slightly convex from this point to dorsal-fin origin; slightly convex along dorsal-fin base; postdorsal profile straight from base of last dorsal-fin ray to adipose-fin origin; slightly concave from adipose-fin to end of caudal peduncle. Ventral profile convex from snout to pelvic-fin insertion; straight or



Figure 3. Recently preserved specimens of *Aphyocharax pusillus*: ANSP 178013, 4, 33.1–54.8 mm SL, Peru, Loreto, Rio Napo (Amazon river basin), right bank just upstream from mouth of Mazan river, near town of Mazan (3°29'10"S, 73°6'24"W). Photographed by Mark Sabaj Perez.

slightly convex from this point to anal-fin origin; straight and posterodorsally-aligned along anal-fin base; postventral profile slightly concave from base of last anal-fin ray to end of caudal peduncle. Snout rounded. Mouth terminal, Lower jaw protrudes slightly beyond upper jaw when mouth closed; aligned approximately to middle of eye. Long and truncated snout, with its length larger than orbital diameter. Mouth terminal; upper jaw slightly larger than lower one. Maxillary bone surpassing a vertical line through middle of the eye; maxillary teeth small and conical, spread along proximal half of the bone. Lateral line interrupted; last scale on caudal-fin base.

There no mention of the presence of a humeral spot in the original description of either *A. pusillus* or *C. alburnus*. Additionally, the type materials of both species do not show any humeral spot. The illustration of *C. alburnus* by Günther (1869, fig. 2), however, gives the impression of the possible presence of a very inconspicuous humeral spot. However, the examination of recently preserved specimens of *A. pusillus* evidences that a very inconspicuous humeral spot could be present on larger recently preserved specimens (Fig. 3). Thus, we conclude that: it does not exhibit a humeral spot on smaller specimens or on specimens preserved several years ago; or

it could possess a very inconspicuous humeral spot on larger and recently preserved specimens (Figs 1–3; Günther 1869, fig. 2). Nominal taxa have black or dark brown middle caudal-fin rays (Figs 1–3; Günther 1869, fig. 2).

Remarks. *Aphyocharax pusillus* is the type species of the genus, designated by monotypy. The specimens were collected by Mr. Bartlett in Xeberos and Huallaga (Amazon River Basin, Peru), and succinctly described by Günther (1868); A. Günther did not, however, state the number of specimens used for the description. Eschmeyer et al. (2018) cite two lots as syntypes (BMNH 1867.6.13.46, 1 syntype, and BMNH 1867.6.13.58–59, 2 syntypes), and this material was examined in the present work.

Chirodon alburnus was succinctly described by Günther (1869) as belonging to the genus *Chirodon* Günther, 1864 because he overlooked the presence of maxillary teeth on the type specimens of *C. alburnus*. According to Maclaine (per. com.), Rosana Souza-Lima designated the specimens BMNH 1869.5.21.10 and BMNH 1869.5.21.11–13 as the lectotype and paralectotypes, respectively, of *Chirodon alburnus* in 2003, but that designation was never published. We concur, and so formally designate BMNH 1869.5.21.10 and BMNH

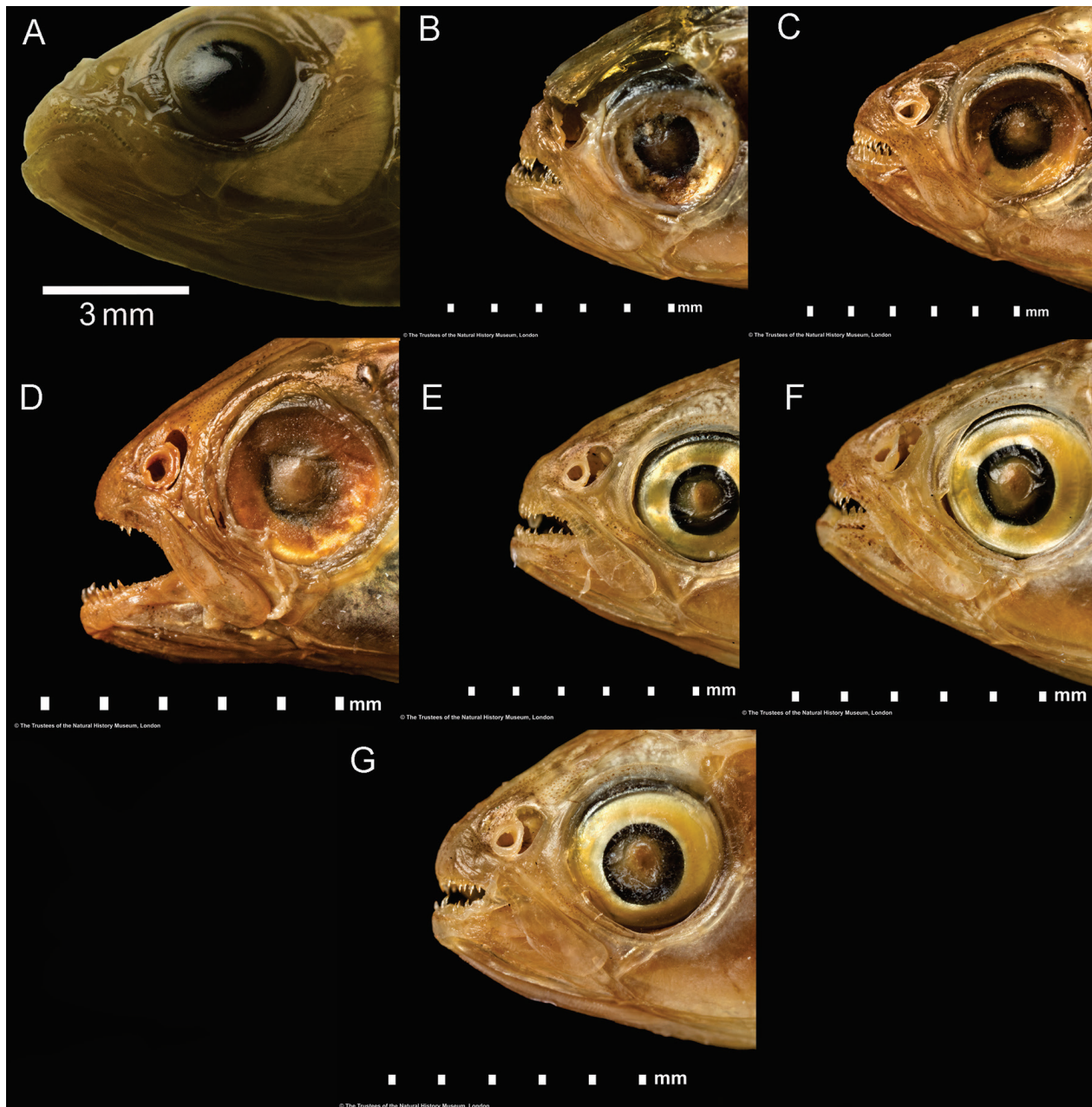


Figure 4. Maxillary teeth of: **A**, Holotype of *Aphyocharax avary*: ANSP 39217; **B**, Syntype of *Aphyocharax pusillus*: BMNH1867.6.12.46; **C**, **D**; Syntypes of *Aphyocharax pusillus*: BMNH 1867.6.13.58-59; **E**, Lectotype of *Chirodon alburnus*: BMNH 1869.5.21.10; **F**, **G**, two of the three paralectotypes of *Chirodon alburnus* (head damaged in a third): BMNH 1869.5.21.11-13. **A**, Photographed by Axel Katz; and **B-G**, Photographed by Kevin Webb.

1869.5.21.11-13 as the lectotype and paralectotypes, respectively, of *Chirodon alburnus*.

Based on the information presented here (type material examination, original descriptions, and the literature) we conclude that *Chirodon alburnus* is a junior synonym of *Aphyocharax pusillus* – as there are no clear diagnostic character states that distinguish those two species. Additionally, the type locality of *Chirodon alburnus* is imprecise (“Peruvian Amazon”), encompassing the type locality of *Aphyocharax pusillus*.

Aphyocharax avary Fowler, 1913

Aphyocharax avary Fowler, 1913:532. Type locality: Madeira River, about 200 miles east of Long. 62°20'W., Brazil. Holotype: ANSP 39217.

Material examined. ANSP 39217, 41.7, 1 (Holotype), Madeira River, about 200 miles east of 62°20'W, Brazil, Sept 1912, Edgar A. Smith.

Diagnosis. *Aphyocharax avary* differs from all of its congeners, except *A. pusillus*, by having black or dark brown



Figure 5. Holotype of *Aphyocharax avary*: ANSP 39217, 41.7 mm SL. Photographed by Axel Katz.

Table 2. Meristic data of *Aphyocharax avary*.

Measurements	ANSP 39217
Pored lateral-line sclaes	13+1
Longitudinal scales	38
Transverse scales	11
Dorsal-fin rays	11 or 12
Pectoral fin-rays	13
Pelvic-fin rays	7
Anal-fin rays	19
Premaxillary teeth	6 or 7
Maxillary teeth	14
Dentary teeth	13 or 14
Vertebrae	34

middle caudal-fin rays (Fig. 5; Fowler, 1913, fig. 8). It can be distinguished from *A. pusillus* by having more teeth on the maxillary, spread along 2/3 of the bone's extension (Fig. 4A) [vs. fewer teeth on the maxillary, spread along only the proximal half of the bone (Fig. 4B–G)].

Morphological notes. Meristic data of the holotype are presented in Table 2.

Body slightly compressed. Dorsal profile slightly convex in the snout region, somewhat flat in the anterior limit of the nasal bone to the extremity of the supraoccipital spine; convex from that point to the dorsal-fin origin; straight through dorsal-fin base; slightly convex after dorsal fin; slightly concave through caudal peduncle. Ventral profile slightly convex from snout to pelvic-fin insertion; straight from this point to the anal-fin origin and through that fin base; slightly concave through caudal peduncle. Snout rounded; eye large compared to the head and snout length; mouth terminal; lower maxilla slightly shorter than upper one. Lateral line interrupted; last scale on caudal-fin base.

Humeral spot conspicuous and middle caudal-fin rays black or dark brown (Fig. 5; Fowler 1913, fig. 8).

Remarks. *Aphyocharax avary* was described by Fowler (1913) based on a single specimen collected by Edgar A. Smith in September 1912 in the Madeira River, approximately 200 miles East of 62°20'W. This collection site is located between the municipalities of Novo Aripuanã-AM and Borba-AM, in the lower Madeira River Basin. The number of maxillary teeth was cited as 4 in the original inscription, although our examination of the holotype counted 14.

Based on the information presented here, we conclude that *A. avary* is a valid species, distinguishable from *A. pusillus* mainly by the number of teeth on the maxillary and their different distributions along that bone (14 maxillary teeth spread along 2/3 of the bone extension vs. 7–8 maxillary teeth spread along the proximal half of the bone) (Fig. 4).

Comparative material

Aphyocharax anisitsi: CICCAA 00867, 14, 25.1–27.9 mm SL, Brazil, Mato Grosso do Sul state, Rio Verde municipality. CICCAA 01267, 6 C&S, 22–26.9 mm SL, Brazil, Mato Grosso do Sul state, Rio Verde municipality. CAS 59697, 1, 41.0 mm SL, Paraguay, Asuncion municipality (Radiograph and photograph of Holotype). *Aphyocharax dentatus*: ANSP 128718, 21, 25.4–34.9 mm SL, Colombia, Lake Mozambique; UFRJ 5571, 2, 23.3–26.0 mm SL, Brazil, Mato Grosso state, Poconé municipality. CAS 59722, 1, 71.0 mm SL, Paraguay, Asuncion municipality, Laguna del Río Paraguay (Radiograph and photograph of Holotype). *Aphyocharax erythrurus* Eigenmann, 1912: FMNH 53406, 1, Guyana: Rockstone sandbank (Photograph of paratype). *Aphyocharax nattereri*: UFRJ 5783, 2, Brazil, Mato Grosso State, Poconé municipality. *Aphyocharax pusillus*: ANSP 178013, 4, 33.1–54.8 mm SL (photographs of recently preserved specimens), Peru, Loreto, Rio Napo (Amazon river basin), right bank just upstream from mouth of Mazan river, near town of Mazan (3°29'10"S, 73°6'24"W). *Aphyocharax rathbuni*: CAS 76467, 1, 26.0 mm SL, Paraguay, Arroyo Chagalalina, Paraguay basin. Paraguay (Radiograph and photograph of a Holotype). *Aphyocharax yekwanae*: FMNH 109278, 1, Venezuela, Bolivarian Republic of (Radiograph of paratype). *Aphyocharax* sp.: CICCAA 00865, 11, 29.9–36.2 mm SL, Brazil, Mato Grosso State, Pontes e Lacerda municipality. CICCAA 2330, 4 C&S, 27.3–32.4, Brazil, Mato Grosso State, Pontes e Lacerda municipality.

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APÊNDICE VIII: Outros Resultados

Título: Pisces, Gobiformes, *Ctenogobius boleosoma* (Jordan & Gilbert, 1882): First record for Maranhão state, northeastern Brazil.

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Pisces, Gobiiformes, Gobiidae, *Ctenogobius boleosoma* (Jordan & Gilbert, 1882): first record for Maranhão state, northeastern Brazil

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Abstract. This study presents *Ctenogobius boleosoma* from the São Luis estuarine region, the first record from the state of Maranhão, northeastern Brazil. This species may have gone unrecorded from Maranhão due to the difficulties in collecting gobies by the usual sampling methods, such as gill nets, corking nets, and longlines, even when using nets with an appropriate mesh size.

Key words. Canal Raposa; São Luis; estuary; ichthyology; Gobionellinae; Darter Goby

Gobiidae is one of the richest vertebrate families, comprising about 1840 valid species in 5 subfamilies (ESCHMEYER et al. 2017). Gobiids are widely distributed throughout the tropical and subtropical regions and occur in marine, estuarine and freshwater environments (NELSON et al. 2016, FROESE & PAULY 2017). The family has extensive recent literature on its taxonomy, phylogeny, and composition, although its taxonomy is not yet stabilized (see NELSON et al. 2016).

The genus *Ctenogobius* Gill, 1858 currently comprises 23 valid species, but only 6 of them are recorded for Brazil: *Ctenogobius boleosoma* (Jordan & Gilbert, 1882), *C. saepepallens* (Gilbert & Randall, 1968), *C. shufeldti* (Jordan & Eigenmann, 1887), *C. smaragdus* (Valenciennes, 1837), *C. stigmaticus* (Poey, 1860) and *Ctenogobius thoropsis* (Pezold & Gilbert, 1987) (FROESE & PAULY 2017). According to PEZOLD (2004), the lack of lobes or gill rakers on the anterior surface of the first epibranchial is the main synapomorphy of *Ctenogobius*. In addition, the genus can be diagnosed by the presence of a short lateral cephalic canal with only 2 pores; 4 or 5 gill

rakers on posterior surface of first gill arch and gill rakers short and triangle shaped; an abbreviated oculoscapular canal that terminates above the preoperculum with an A'BCDFH' pattern; a simple or triangulate fourth neural spine; and a diagonal posterior opercular neuromast row (SMITH 1997, MURDY & HOESE 2002, ROSS & RHODE 2004, PEZOLD 2004).

Ctenogobius boleosoma is distributed from North Carolina (USA), the Bahamas, and the northern Gulf of Mexico to the estuarine region of Rio Grande do Sul (Brazil). This species is known to occur in the following Brazilian states: Bahia, Ceará, Espírito Santo, Pará, Paraíba, Paraná, Pernambuco, Rio de Janeiro, Rio Grande do Norte, Rio Grande do Sul, São Paulo, and Santa Catarina (ROSA et al. 1997; ARAÚJO et al. 2000; BIZERRIL & COSTA 2001; JOYEUX et al. 2004; CLAUZET et al. 2005; SARPEDONTI et al. 2008; REIS-FILHO et al. 2010; PAIVA AND ARAUJO 2010; SPACH et al. 2010; MENEZES 2011; PASSOS et al. 2012; MACHADO 2013; COSTA et al. 2013; LIMA-FILHO et al. 2014; OLIVEIRA & PESSANHA 2014; SARMENTO-SOARES & MARTINS-PINHEIRO 2014; BORGIO et al. 2015; MOLITZAS 2015; LAMAS et al. 2016; PETRY et al. 2016; FROESE & PAULY 2017; ESCHMEYER et al. 2017). The present study presents the first record of *C. boleosoma* from the state of Maranhão, northeastern Brazil.

One specimen of *C. boleosoma* (Fig. 1) was collected at the estuary of the Canal Raposa, Raposa Municipality, north end of Ilha de São Luis, Maranhão (02°25'22" S, 044°05'21" W; leg. P. Brito and A. Ramos, 6 June 2013) (Figs. 2, 3). The water temperature was 27.9 °C; dissolved oxygen, 10.4 mg/L; water salinity, 37‰; and water depth, approximately 50 cm.

The collection was conducted during the daytime period,



Figure 1. *Ctenogobius boleosoma*: CICCAA 00202, 38.3 mm SL; estuary of Canal Raposa, Ilha de São Luis, Maranhão, northeastern Brazil.



Figure 2. Records of *Ctenogobius boleosoma* in Brazil: red state – Maranhão state, the new documented state where the species occurs; green states – Brazilian states where the species was previously recorded according to the literature cited below; red circle – new record for the Canal Raposa, Maranhão state; and green circles – records based on the literature (ROSA et al. 1997, ARAÚJO et al. 2000, BIZERRIL & COSTA 2001, JOYEUX et al. 2004, CLAUZET et al. 2005, SARPEDONTI et al. 2008, REIS-FILHO et al. 2010, PAIVA & ARAUJO 2010, SPACH et al. 2010, PASSOS et al. 2012, MACHADO 2013, COSTA et al. 2013, LIMA-FILHO et al. 2014, OLIVEIRA & PESSANHA 2014, SARMENTO-SOARES & MARTINS-PINHEIRO 2014, BORGIO et al. 2015, MOLITZAS 2015, LAMAS et al. 2016, PETRY et al. 2016, FROESE & PAULY 2017, ESCHMEYER et al. 2017).

using a manual trail-net (20 m long × 5 m high; mesh size, 5 mm). This net was trailed by 2 collectors, each one at one extremity of the net, through salt marshes of *Spartina alterniflora* Lousiel (Fig. 3). The collected specimen was fixed in 10% formalin immediately after capture and after 15 days transferred to 70% alcohol for preservation. This material is deposited in the Coleção Ictiológica do Centro de Ciências Agrárias e Ambientais da Universidade Federal do Maranhão (CICCAA 00202). Sampling was conducted under permit

(“Autorização para atividade com finalidades científicas”, No. 30346-1). Counts and measurements were made according to MURDY & HOESE (2002), and the classification follows NELSON et al. (2016).

The species was identified as *C. boleosoma* (Fig. 1) based on the presence of the following diagnostic characters according to the literature (MURDY & HOESE 2002; PEZOLD 2004; FROESE & PAULY 2017): predorsal area naked; no circular spots on sides of head; 5 round or elongate dark blotches along



Figure 3. Collecting site of *Ctenogobius boleosoma*; estuary of Canal Raposa, Ilha de São Luis, Maranhão state, northeastern Brazil.

midside; 31 scales on lateral row; canine teeth smaller than those of its congeners; and diagonal marks extending upward to form V-shapes. Some meristic and morphometric data of the examined specimen of *C. boleosoma* are presented in Table 1.

The new record is the first documented occurrence of *C. boleosoma* in the estuary of Ilha de São Luis (Figs. 2, 3), as well as the first known occurrence from Maranhão, and helps fill in the gaps in the geographical distribution of this goby species. This new record is significant due to the relative scarcity of knowledge of the ichthyofauna of Maranhão to other states in southern and southeastern Brazil. Most of the ichthyofaunal inventories in Maranhão, including those in marine and estuarine habitats, have used gill nets, corking nets, and longlines, which usually focus on larger species that are important for fisheries but not efficient ways to collect small specimens (e.g., MARTINS-JURAS et al. 1987; ROCHA AND ROSA 2001; ARAUJO-JUNIOR et al. 2005; NETA & CASTRO 2008; NUNES et al. 2011).

Table 1. Meristic data of *Ctenogobius boleosoma* from the estuary of Canal Raposa, Ilha de São Luis, Maranhão state, northeastern Brazil (CICCAA 00202).

Character	
Standard length (SL)	38.3 mm
Percents of standard length	
Head length (HL)	24.7
Body	12.3
Head depth	13.5
Predorsal distance	34.5
Prepectoral distance	21.7
Prepelvic distance	19.6
Preanal distance	48.8
Percents of head length	
Horizontal eye diameter	17.2
Counts	
Second dorsal-fin total elements	11
Pectoral-fin total elements	16
Anal-fin total elements	13
scales on lateral row	31

Thus, *C. boleosoma* could have gone unrecorded from Maranhão because of this species' small size (maximum total length, 7.5 cm; FROESE & PAULY 2017). However, even with nets with an appropriate mesh size, it is often difficult to collect *C. boleosoma* over muddy bottoms because this species burrows into the bottom to avoid capture. Rotenone remains the best method to assess the diversity and quantify abundance of gobies, and the hesitation to allow use it is major reason why we have gaps in our knowledge of goby distributions.

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APÊNDICE IX: Outros Resultados

Título: First record of *Butis koilomatodon* (Bleeker, 1849) (Gobiiformes: Eleotridae) for the Maranhão state, northeastern Brazil: a case of bioinvasion

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First record of *Butis koilomatodon* (Bleeker, 1849) (Gobiiformes: Eleotridae) for the Maranhão state, northeastern Brazil: a case of bioinvasion

by

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Résumé. – Premier signalement de *Butis koilomatodon* (Bleeker, 1849) (Gobiiformes : Eleotridae) dans l'état de Maranhão, nord-est du Brésil : un cas de bioinvasion.

L'espèce invasive, *Butis koilomatodon* (Bleeker, 1849), a été signalée pour la première fois dans l'état de Maranhão, sur la plage Araçagy à São Luis, dans le nord-est du Brésil.

Key words. – Eleotridae - *Butis koilomatodon* - Atlantic Ocean - Northern Brazil - Invasive species - First record.

Biological invasions are among the main agents of climate change around the world (Miller *et al.*, 1989). Invasive species often coexist with native species for a prolonged time and gradually, the superior competitive ability of the invaders becomes evident, occasionally causing dramatic effects on the native biodiversity and habitat composition (Lasso-Alcalá *et al.*, 2011). *Butis koilomatodon* (Bleeker, 1849) is an eleotrid species, which occurs natively in the coastal regions and estuaries throughout most of the Indo-Pacific Ocean between China, Philippines, Australia, and Madagascar (Miller *et al.*, 1989). Invasion by *B. koilomatodon* has been recorded for Panama (Dawson, 1973); Nigeria, Guinea and Cameroon (Miller *et al.*, 1989; Vreven *et al.*, 2007); Venezuela (Lasso-Alcalá *et al.*, 2005); and Brazil, occurring in the following states: Bahia, Espírito Santo, Pará, Rio Grande do Norte, São Paulo and Sergipe (Macieira *et al.*, 2012; Soares *et al.*, 2012; Contente *et al.*, 2016). The present work firstly records the occurrence of this bioinvader for the Maranhão state, northeastern Brazil, and compiles its records of invasion in Brazil.

MATERIALS AND METHODS

The specimen herein examined was fixed in a solution of formalin 10% just after its capture, and then transferred to a solution of alcohol 70%. The collected material was deposited in the Coleção Ictiológica do Centro de Ciências Agrárias e Ambientais (CICCAA) of the Universidade Federal do Maranhão, with the following information and catalogue number: CICCAA 00400, 1, 41.0 mm SL, Araçagy Beach (02°28'46"S; 44°13'55"W), São Luis, Maranhão state, Brazil; P. Brito and E. Guimarães; 23 Oct. 2016. Counts were made according to Macieira *et al.* (2012).



Figure 1. – Life specimen of *Butis koilomatodon*: CICCAA 00400, 41.0 SL; Araçagy Beach, São Luis, Maranhão state, northeastern Brazil.

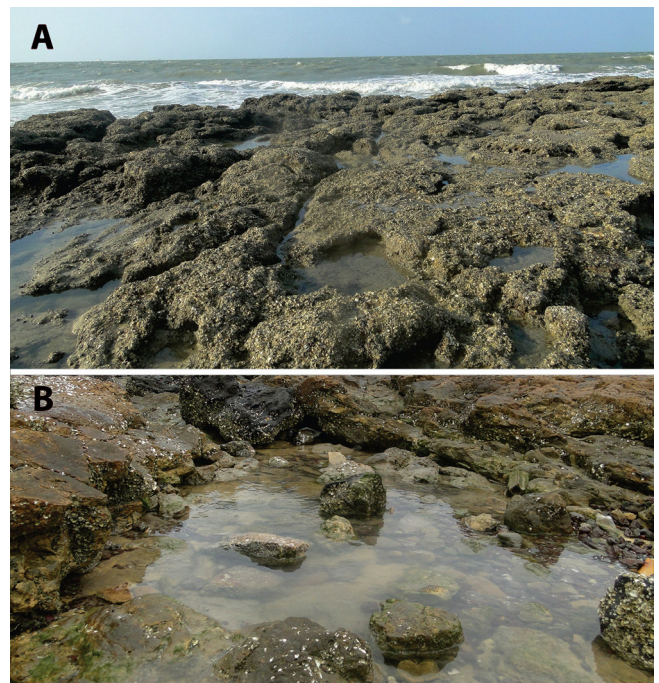


Figure 2. – Collecting site of *Butis koilomatodon*. **A:** Rock shore at Araçagy Beach, São Luis, northeastern Brazil; **B:** Rock tide pool where the specimen was collected.

RESULTS

One specimen of the invasive species *B. koilomatodon* (Fig. 1) was collected in one rock tide pool at Araçagy Beach (Fig. 2), São

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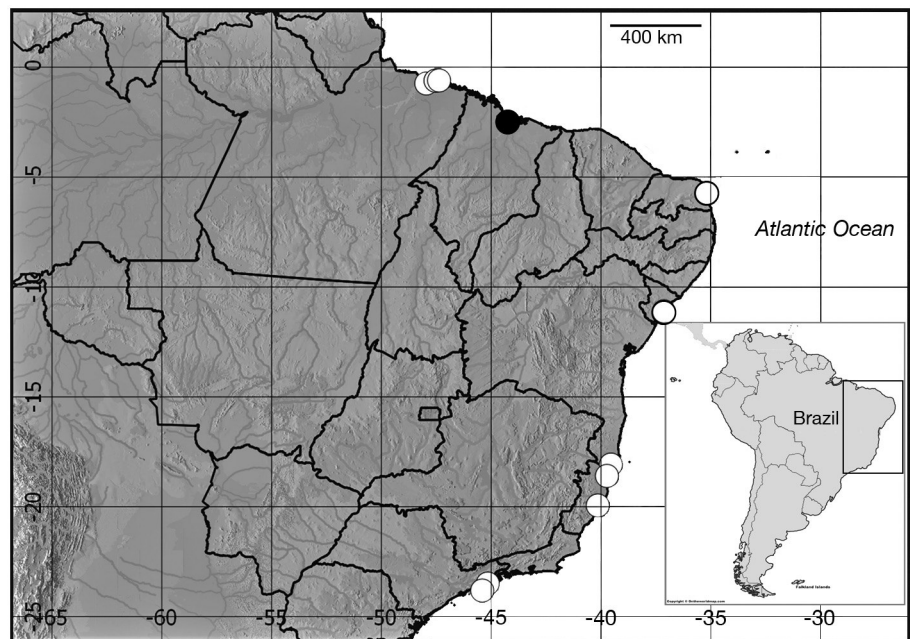


Figure 3. – Distribution of the invasive species *Butis koilomatodon* in Brazil. Black circle: new record for the Maranhão state; white circles: records based on the literature (Macieira *et al.*, 2012; Soares *et al.*, 2012; Contente *et al.*, 2016).

Luis, Maranhão state, northeastern Brazil, possessing the following parameters: temperature = 28.5°C, dissolved oxygen = 8.20 mg/L and salinity = 32.5‰. This is the first record of this invasive species for the state. In addition, all its invasion records for Brazil were compiled on a map (Fig. 3). The meristic and morphological data of the specimen herein examined are as follows:

Dorsal fin counts - IV+9; anal fin counts - I+8; 21 pectoral fin rays; second dorsal and caudal fins alternating dark brown and yellowish brown bars; anal and pelvic fins dark brown to black; pectoral fins hyaline brown. This species is distinguished from its congeners by having four to seven regular bands on the body and a serrated process on the snout (Vreven *et al.*, 2007, Macieira *et al.*, 2012). In the same rock tide pool where *B. koilomatodon* was found, a second exotic fish, *Omobranchus punctatus* (Valenciennes, 1836) (Blenniidae) was collected, already recorded for the Maranhão coast by Lasso-Alcalá *et al.* (2011).

DISCUSSION

The ecological consequences caused by the presence of *B. koilomatodon* in this region are unpredictable. The biological traits of this species, such as its cryptic behaviour and its diet based mainly on crustaceans and smaller fishes, could affect or impact the populations of the native species of invertebrates and fishes in many ways. Some of these consequences are the interspecific competition, and species extinction, caused by both competition and predation (Lasso-Alcalá *et al.*, 2011).

Contente *et al.* (2016) cited Loebmann *et al.* (2010) as having recorded *B. koilomatodon* for the Delta do Parnaíba, northeastern Brazil. This citation is wrong because Loebmann *et al.* (2010) just recorded one alien fish species, *Omobranchus punctatus*, but never *B. koilomatodon*.

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ANEXO

ANEXO I: INSTRUCTIONS TO AUTHORS ZOOSYSTEMATICS AND EVOLUTION

Main Text

Title: The title should be in a sentence case (only scientific, geographic or person names should be with a first capital letter, i.e. *Elater ferrugineus* L., Germany, etc.), and should include an accurate, clear and concise description of the reported work, avoiding abbreviations. The higher taxa within the title should be separated with commas and not with a semicolon, e.g.: (Coleoptera, Elateridae, Elaterini). Please enter the desired running title for the page headings in brackets.

Authors and Affiliations: Provide the complete names of all authors, and their addresses for correspondence, including e.g., institutional affiliation (e.g. university, institute), location (street, boulevard), city, state/province (if applicable), and country. One of the authors should be designated as the corresponding author. It is the corresponding author's responsibility to ensure that the author list, and the individual contributions to the study are accurate and complete. If the article has been submitted on behalf of a consortium, all consortium members and their affiliations should be listed after the Acknowledgements section. **Abstract and Keywords:** Please have your abstract and keywords ready for input into the submission module. The abstract should contain max. 250 words. A maximum of 10 key words may be given, which are not already in the title.

Body Text: Manuscripts must be submitted in English. Authors should confirm the English language quality of their texts or alternatively request thorough linguistic editing prior to peer-review at a price. Manuscripts written in poor English are a subject of rejection prior to peer-review. Use either British/Commonwealth or American English provided that the language is consistent within the paper. Each text must be written with precision, clarity, and economy, whenever appropriate in active voice and first person. Avoid the use of parenthetical comments and italics or bold for emphasis. This journal discourages the use of quotation marks except for direct quotations, words defined by the author, and words used in unusual contexts. Short quotations should be embedded in the text and enclosed in double quotation marks (""). Long quotations should be on a separate line, italicized, but without quotation marks. Single quotation marks are to be used only for a quotation that occurs within another quotation.

Spacing, Fonts, and Page Numbering: Single-space all material (text, quotations, figure legends, tables, references, etc.). Separate paragraphs with a blank line. Use a 12-point font (preferably Times New Roman or Arial). **Capitals:** First capital letters should be used only in the beginning of a sentence, in proper names and in headings and subheadings, as well as to indicate tables, graphs and figure/s within the text. Software programmes should be written with capital letters (e.g., ANOVA, MANOVA, PAUP).

Italicization/Underlining: Scientific names of species and genera, long direct quotations and symbols for variables and constants (except for Greek letters), such as p , F , U , T , N , r ,

but not for SD (standard deviation), SE (standard error), DF (degrees of freedom) and NS (non significant) should be italicized. These symbols in illustrations and equations should be in italics to match the text. Italics should not be used for emphasis, and not in abbreviations such as e.g., i.e., et al., etc., cf. Underlining of any text is not acceptable.

Abbreviations: Abbreviations should be followed by '.' (full stop or period; for instance: i.e., e.g., cf., etc.). Note that you shouldn't add a full stop at the end of abbreviated words if the last letter of the abbreviation is the same as the last letter of the full word. For example, you should abbreviate "Eds", "Dr", "Mr" without full stop at the end. All measures, for instance mm, cm, m, s, L, should be written without full stop.

On the use of dashes: (1) Hyphens are used to link words such as personal names, some prefixes and compound adjectives (the last of which vary depending on the style manual in use) (2) En-dash or en-rule (the length of an 'n') is used to link spans. In the context of our journal en-dash should be used to link numerals, sizes, dates and page numbers (e.g., 1977–1981; figs 5–7; pp. 237–258); geographic or name associations (Murray–Darling River; a Federal–State agreement); and character states combinations such as long–pubescent or red–purple. (3) Em-dash or em-rule (the length of an 'm') should be used rarely, only for introducing a subordinate clause in the text that is often used much as we use parentheses. In contrast to parentheses an em-dash can be used alone. En-dashes and em-dashes should not be spaced.

Footnotes: Avoid footnotes in the body text of the manuscript. It is always possible to incorporate the footnote into the main text by rewording the sentences, which greatly facilitates reading. Additionally, footnotes are not always handled well by the journal software, and their usage may cause a failure of submission. Footnotes are acceptable only below tables; instead of numbers, please use (in order): †, ‡, §, |, ¶, #, ††, ‡‡, §§, ||, ¶¶, ##.

Geographical coordinates: It is strongly recommended to list geographical coordinates as taken from GPS or online gazetteer, or georeferencer (<http://wiki.tdwg.org/twiki/bin/view/DarwinCore/GeospatialExtension>). Geographical coordinates must be listed in one of the following formats

Definition: The locality consists of a point represented by coordinate information in the form of latitude and longitude. Information may be in the form of Degrees, Minutes and Seconds (DMS), Degrees and Decimal Minutes (DDM), or Decimal Degrees (DD).

Records should also contain a hemisphere (E or W and N or S) or, with Decimal Degrees, minus (–) signs to indicate western and/or southern hemispheres.

Examples: Example 1: 36° 31' 21" N; 114° 09' 50" W (DMS)

Example 2: 36° 31.46'N; 114° 09.84'W (DDM)

Example 3: 36.5243° S; 114.1641° W (DD)

Example 4: -36.5243; -114.1641 (DD using minus signs to indicate southern and western hemispheres)

Note on accuracy: Because GPS units are very commonly used today to record latitude/longitude, many authors simply give the GPS readings for their localities. However, these readings are much too accurate. For example, a GPS unit might give the latitude in decimal seconds as 28°16'55.87"N. Since one second of latitude is about 30 m on the ground, the second figure after the decimal in 55.87 represents 30 cm, yet a typical handheld GPS unit is only accurate at best to a few metres.

We therefore recommend two ways to report GPS-based locations. If you give the GPS reading without rounding off, make sure you include an uncertainty figure as a context for the over-accurate GPS reading. We recommend the Darwin Core definition of uncertainty (<http://rs.tdwg.org/dwc/terms/index.htm#coordinateUncertaintyInMeters>): "The horizontal distance (in meters) from the given decimalLatitude and decimalLongitude describing the smallest circle containing the whole of the Location."

If you only give the GPS reading, please round it off to an implied precision appropriate to the error in the measurement, or to the extent of the area sampled. We suggest rounding off to the nearest second in degree-minute-second format (28°16'56"N), which implies roughly ± 25 -30 m at middle latitudes to four decimal places in decimal degree format (28.2822°N), which implies roughly ± 10 -15 m at middle latitudes to two decimal places in decimal minute format (28°16.93'N), which implies roughly 15-20 m at middle latitudes

Altitude: Many GPS users simply record the elevation given by their GPS unit. However, GPS elevation is NOT the same as elevation above sea level. GPS units record the elevation above a mathematical model of the earth's surface. The difference between this elevation and elevation above sea level can be tens of metres. In any case, the accuracy of a GPS elevation is often the same as the usual accuracy in horizontal position, so a GPS elevation such as '753 m' is much too accurate and should be rounded off to 'ca 750 m'.

We strongly recommend the use of Example 2 (the DDM format). The other three are also possible but will be recalculated to DDM during the process of online mapping from the HTML version of the paper. The only restriction on format is in creating a KML (Keyhole Markup Language) file. KML latitudes and longitudes must be in the DD format shown above in Example 4. Please also consider submitting a table of localities with your manuscript, either as a spreadsheet or in CSV text format. By doing so you will make your specimen localities much more easily available for use in biodiversity databases and geospatial investigations. The geospatial table will be put online as supplementary material for your paper. A minimum table will have three fields: species (or subspecies) name, latitude and longitude. A full table will have the same data for each specimen lot as appears in the text of your paper. Please check latitude/longitude carefully for each entry.

Units: Use the International System of Units (SI) for measurements. Consult Standard Practice for Use of the International System of Units (ASTM Standard E-380-93) for guidance on unit conversions, style, and usage.

Statistics: Use leading zeroes with all numbers, including probability values (e.g., $P < 0.001$). For every significant F-statistic reported, provide two df values (numerator and denominator). Whenever possible, indicate the year and version of the statistical software used. Web (HTML) links: Authors are encouraged to include links to other Internet resources in their article. This is especially encouraged in the reference section. When inserting a reference to a web-page, please include the http:// portion of the web address.

Supplementary files: Larger datasets can be uploaded separately as Supplementary Files. Tabular data provided as supplementary files can be uploaded as an Excel spreadsheet (.xls), as an OpenOffice spreadsheets (.ods) or comma separated values file (.csv). As with all uploaded files, please use the standard file extensions. Headings and subheadings: Main headings: The body text should be subdivided into different sections with appropriate headings. Where possible, the following standard headings should be used: Introduction, Methods, Results, Discussion, Conclusions, Acknowledgements, References. These headings need to be in bold font on a separate line and start with a first capital letter. Please do not number headings or subheadings.

Introduction – The motivation or purpose of your research should appear in the Introduction, where you state the questions you sought to answer, and then provide some of the historical basis for those questions.

Methods – Provide sufficient information to allow someone to repeat your work. A clear description of your experimental design, sampling procedures, and statistical procedures is especially important in papers describing field studies, simulations, or experiments. If you list a product (e.g., animal food, analytical device), supply the name and location of the manufacturer. Give the model number for equipment used. Supply complete citations, including author (or editor), title, year, publisher, and version number, for computer software mentioned in your article

Results – Results should be stated concisely and without interpretation. **Discussion** – Focus on the rigorously supported aspects of your study. Carefully differentiate the results of your study from data obtained from other sources. Interpret your results, relate them to the results of previous research, and discuss the implications of your results or interpretations. Point out results that do not support speculations or the findings of previous research, or that are counter-intuitive. You may choose to include a Speculation subsection in which you pursue new ideas suggested by your research, compare and contrast your research with findings from other systems or other disciplines, pose new questions that are suggested by the results of your study, and suggest ways of answering these new questions.

Conclusion – This should state clearly the main conclusions of the research and give a clear explanation of their importance and relevance. Summary illustrations may be included.

References – The list of References should be included after the final section of the main article body. A blank line should be inserted between single-spaced entries in the list. Authors are requested to include links to online sources of articles, whenever possible! Where possible, the standard headings should be used in the order given above. Additional headings and modifications are permissible. Subordinate headings: Subordinate headings (e.g. Field study and Simulation model or Counts, Measurements and Molecular analysis), should be left-justified, italicized, and in a regular sentence case. All subordinate headings should be on a separate line. English Language Editing

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followed the above requirement:

☐ I confirm that the use of English language in this manuscript is proficient. I am aware that manuscripts in poor English will be rejected prior to peer-review. The submission process includes an option to request a professional linguistic and copy editing at a price of EUR 15 per 1800 characters:

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Citations and References

Citations within the text: Before submitting the manuscript, please check each citation in the text against the References and vice-versa to ensure that they match exactly. Two authors are named and connected by "and"; three or more authors are abbreviated to "et al". Several citations are separated by a comma. Citations in the text should be formatted as follows: Smith (1990) or (Smith 1990), Smith et al. (1998) or (Smith et al. 1998) and (Smith et al. 1998, 2000, Brock and Gunderson 2001, Felt 2006).

References: It is important to format the references properly, because all references will be linked electronically as completely as possible to the papers cited. It is desirable to add a DOI (digital object identifier) number for either the full-text or title and abstract of the article as an addition to traditional volume and page numbers. If a DOI is lacking, it is recommended

to add a link to any online source of an article. List all authors cited in the References. For multiauthored papers, give all author names in full; the abbreviation "et al." is only allowed in the text. All journal titles should be spelled out completely and should not be italicized. In the case of Chinese authors the first names must also be given in full. Ensure that the References are complete and arranged according to name and year of publication. Personal communications and submitted manuscripts should be listed as unpublished results in the text and not listed in the References section.

The references should conform to the rules shown in the following examples:

Journal Article

Herman LH (2001) Catalog of the Staphylinidae (Insecta, Coleoptera). 1758 to the end of the second Millennium. VI. Staphylininae group (Part 3). Bulletin of the American Museum of Natural History 265: 3021–3839.

McAtee WL, Malloch JR (1923) Notes on American Bactrodinae and Saicinae. (Heteroptera: Reduviidae). Annals of the Entomological Society of America 16 (3): 247–254.

Zhang L, Yang D (2003) Notes on the genus *Hercostomus* Loew, 1857 from Guangxi, China (Diptera: Empidoidea: Dolichopodidae). Annales Zoologici 53 (4): 657–661.

Staniec B, Pietrykowska-Tudruj E (2007) Developmental stages of *Philonthus rubripennis* Stephens, 1832 (Coleoptera, Staphylinidae, Staphylininae) with comments on its biology. Deutsche Entomologische Zeitschrift 54 (1): 95–113.

Book

Bright DE, Skidmore RE (2002) A catalog of Scolytidae and Platypodidae (Coleoptera). Supplement 2 (1995–1999). NRC Research Press, Ottawa.

Hinton HE (1981) Biology of insects eggs. Vol. 2. Pergamon Press, Oxford, 531 pp.
Book Chapter

De Jong R (1998) Halmahera and Seram: different histories, but similar butterfly faunas. In Hall R and Holloway JD (eds). Biogeography and geological evolution of SE Asia. Backhuys Publishers, Leiden: pp. 315–325. Link/URL: BBC News: Island leopard deemed new species <http://news.bbc.co.uk/> Cite the journal as "Zoosystematics and Evolution"

Citations of Public Resource Databases: It is highly recommended all appropriate datasets, images, and information to be deposited in public resources. Please provide the relevant accession numbers (and version numbers, if appropriate). Accession numbers should be

provided in parentheses after the entity on first use. Examples of such databases include, but are not limited to: ZooBank (www.zoobank.org), Morphbank (www.morphbank.net), Genbank (www.ncbi.nlm.nih.gov/Genbank), BOLD (www.barcodinglife.org).

Providing accession numbers to data records stored in global data aggregators allows us to link your article to established databases, thus integrating it with a broader collection of scientific information. Please hyperlink all accession numbers through the text or list them directly after the References in the online submission manuscript. Authors are encouraged to cite in the References list the publications of the original descriptions of the taxa treated in their manuscript. Illustrations, Figures and Tables

General notes on illustrations: Figures must be submitted electronically and must be of sufficient resolution for printing. All illustrations should be prepared according to the format of the journal, such that the figure fills the entire page width (165 mm), or the column width (81 mm), and will not exceed the maximum page length (247 mm). Please submit each figure as a single file and ready for printing at final publication size. Do not integrate the illustrations within your text files of the final version, since embedded figures are usually useless and cannot be processed.

The preferred file formats are TIFF and PSD for grayscale illustrations and EPS for vector graphics. Please do not send JPG or GIF files, as these are usually not of high enough quality for the printed version. Should you have any problems in providing the figures in one of the above formats, or in reducing the file below 20 MB, please contact the Editorial Office at zse@pensoft.net. Figures: Please submit figure files (photographs, raster images) electronically, with a minimum resolution of 300 dpi as TIFF or better as PSD (Photoshop). Do not reduce multiple layers to one layer.

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Take care to optimize the contrast, and use only photographs that are sharp and in focus. Please use a white background for photographs, which will be printed in black and white. When grouping several figures into one plate, it is important to pay attention to the overall brightness of the individual figures. Please leave a margin of 2–5 mm between the figures. Vector graphics and line drawings: Line drawings such as diagrams, maps, etc. should be submitted in EPS format, which is the preferred file format for vector graphics. However, you can also submit Adobe Illustrator files. EPS files must contain a TIFF preview. Vector graphics and line drawings must have a printable line thickness of at least 0.2 mm, to enable a sufficiently good print quality. Fonts must be embedded

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Text in illustrations: Text in illustrations should be as short as possible in sans-serif type (Arial or Helvetica) and regular style. Abbreviations should only be used in the illustration where absolutely necessary, and explained in the legend in alphabetical order. All figures must be accompanied by scale bars. Measurements must be in metric units. Several figures grouped together with one common legend need to be numbered using a sans-serif typeface (Arial, Helvetica) and should be arranged according to the numbers. The height of the text should be in relation to the size of the figure and be at least 1.5 mm in the final figure size.

Illustration captions: Please enter the captions on a separate page and list them in the correct order at the end of the manuscript. Figure captions should begin with ‘Figure’ or ‘Figures’ in all caps. Short title of figure (maximum 15 words) and detailed legend (if present, up to 300 words) should be listed consecutively. Figures are referred to in the captions using Arabic numerals, followed by a point (both in bold type). Thereafter use capital letters and separate the captions with a semicolon. Abbreviations are also printed in bold type and are listed in alphabetical order. Please use an em-dash between abbreviation and explanation. Follow the example:

Figure 2. Habitat of *Mediocris commenticius*

Figures 1–3. *Mediocris commenticius* gen. n. sp. n. from Kovácsszénája, Hungary. 1. Dorsal view; 2. Ventral view; am – antenna muscle; ts III – 3rd thorax segment. Please note that the items in the abbreviations are listed alphabetically, based on the abbreviation. 3. ...

Positioning of figures: Please show the preferred position for an illustration in the manuscript by way of a clear notice: (FIGURE XY) on a separate line.

Copyright clearance: Please note that it is the responsibility of the author(s) to obtain permission from the copyright holder to reproduce figures or tables that have previously been published elsewhere.

Tables: Each table should be numbered in sequence using Arabic numerals (i.e. Table 1, 2, 3 etc.). Tables should not repeat information that is already in the text. Tables should also have a title that summarizes the whole table, maximum 15 words. Detailed legends may then follow, but should be concise. Each abbreviation used in the table has to be explained in the caption or in footnotes. If table footnotes are necessary these should be listed at the end of the table

Small tables can be embedded within the text, in portrait format (note that tables on a landscape page must be reformatted onto a portrait page or submitted as additional files). These will be typeset and displayed in the final published form of the article. Such tables should be formatted using the 'Table object' in a word processing program to ensure that columns of data are kept aligned when the file is sent electronically for review. Do not use tabs to format tables or separate text. All columns and rows should be visible, please make sure that borders of each cell display as black lines. Colour and shading should not be used; neither should commas be used to indicate decimal values. Please use a full stop to denote decimal values (i.e., 0.007 cm, 0.7 mm). The size of the table should largely correspond to the printed format (single-column 81 × 247 mm; two-column 165 × 247 mm).

Larger datasets can be uploaded separately as Supplementary Files. Tabular data provided as supplementary files can be uploaded as an Excel spreadsheet (.xls), as an OpenOffice spreadsheets (.ods) or comma separated values file (.csv). As with all uploaded files, please use the standard file extensions.

Taxonomic Treatments

General guidelines

By publishing in this journal you are already creating a modern taxonomic product that is more accessible than previous print only works. The following guidelines are provided to ensure that other elements of the work follow modern standards and enable the full advantage of this platform. Include unique specimen identifiers for type material. Unique identifiers are for example museum collections specimen IDs. Unique identifiers can be provided also

by international taxon-based databases that do not indicate ownership, such as AntWeb.org for ants, for example.

Holotype should not deposited in private collections.

Include images of type material or representative species. Imaging is not a technical problem anymore and is provided by many institutional collections or international taxon-based services (again, AntWeb.org is a good example as they will provide free imaging of ant type material if necessary).

Specimen data of material examined provided as auxiliary file as a .txt or .csv file or table at end of document, based on the Darwin Core standard. Specimen file should include unique specimen identifiers when possible. Include latitude, longitude, elevation, habitat, microhabitat information of primary type material. For format of geographical coordinates see section "Main text" above. Provide dichotomous key of taxa or related taxa (i.e. species group) or links to online-based keys.

Single species descriptions should be clearly justified with regard as to why a more detailed larger scale, comparative revision was not conducted. For descriptions of single species see also section "Focus and scope". Sequence data Manuscripts containing novel amino acid sequences (e.g. primer sequences) will only be accepted if they carry an International Nucleotide Sequence Databases (INSD) accession number from the European Biology Laboratory (EMBL), GenBank Data Libraries (GenBank) or DNA Data Bank of Japan (DDBJ). We strongly recommend that authors include institutional catalog numbers for specimens preserved in collections, and information identifying sequences that are derived from type specimens (see below) when they deposit data in genetic databanks. A summary table with the INSD accession [catalog] numbers should be included in either Materials and Methods or Data Resources section of the paper. If specimens were not vouchered (tissued specimens should be vouchered whenever possible!), collection locality data and possibly photographs of tissued specimens must be provided. A nomenclature for genetic sequences for types and confidently identified nontype specimens has been proposed by Chakrabarty et al. (2013); a sequence from a holotype is identified as genseq-1, one from a paratype is identified as genseq-2, one from a topotype is genseq-3, etc. The genetic marker(s) used should also be incorporated into the nomenclature (e.g. genseq-2 COI).

International Code for Zoological Nomenclature

Zoosystematics and Evolution will publish papers that strictly adhere the rules of the last edition of the International Code of Zoological Nomenclature and its amendment. To assure this, authors are advised to follow the recommendations below and the Best practice in the use of the scientific names of animals. General: Each first mentioning of an animal species name within the text must be provided with author(s)' name(s). Year of publication of an animal species should be given in taxonomic revisions with quotation of the work providing

the original species' description in the list of references. New names: When new taxonomic alterations are proposed the taxonomic act should be indicated by adding its abbreviation, i.e., sp. n., comb. n., stat. n. after the taxon name. Same refer to high taxonomic ranks such as subfamily, family, suborder, etc. Authors names should be specified throughout the text if different from the authors of publication

Examples: Genus X-us Smith, new genus (author(s) of the publication and authority (-ies) of the taxon is/are identical); X-us albus Jones & Peters, new species (the publication is authored by persons different in composition or combination from the authority (-ies) of the taxon itself, e.g. Smith, Jones & Peters or Peters & Jones). New family-group names: Although all family group names are derived/based on their type genus, the type genus is to be compulsorily designated in any description of a family-group name published after 31st December 1999 (Article 16.2). It is not sufficient that the type genus is mentioned as belonging to the new family-group name; it must be stated that this is the type genus. We recommend a single type line as: Type-genus: *Musca* Linnaeus, 1758. New genus-group names: The origin ("etymology", or "derivatio nominum") of name and its gender should be indicated. The type-species and the character of the proposed taxonomic act should be specified for new genus-group names. The type species name should be given in its original combination with an author and year. If the type species is now considered a junior synonym there need to be a clear mention of that. The fixation type should derive from the International Code of Zoological Nomenclature (see Articles 68 & 69; original designation, monotypy, absolute tautonymy, Linnaean tautonymy, subsequent monotypy, subsequent designation).

Example:

- *Sympycnus* Loew

Type-species: *Porphyrops annulipes* Meigen, 1824 by subsequent designation of Coquillett (1910: 610) = *pulicarius* Fallen, 1823

New species-group names: According to the ICZN Art. 11.9, but also Art. 11.3 the origin "etymology", or "derivatio nominum") new species-group names should be supplemented by information on whether the epithet is an 1) adjective or participle in the nominative singular; 2) noun in the nominative singular; 3) a noun in the genitive case; 4) an adjective used a substantive in the genitive case; or 5) an arbitrary combination of letters (ICZN Art. 11.3). For **species-group names**, there are two separate statements of type information that are needed:

- **the statement of species' type locality** – that is the exact place whence the primary type origins, including exact collecting dataplace with geographical coordinates, geographical or political unit (Area/ District/ State) and country; also, if possible, supplementary locality information should be included – habitat type, method of collecting, date, collector's names, host name (for parasites), etc. there should be a

separate statement about the **type specimen**, exact quotation of its original label, condition of specimen (dry pinned, in alcohol, slide, fossil, etc.) and repository (organization's name and city).

Examples:

- For a **new species**: Type-locality: USA, Virginia: Fairfax County, Kingstowne, 38°46'N, 77°07'W, broad-leaf forest, under bark, 10 July 2000, J. Smith leg.
- **Type-specimen**: Holotype male, pinned, with genitalia in a separate microvial. Original label: "USA, VA, Fairfax, Kingstowne, 38°46'N, 77°07'W, 12 Oct 2003, BJ & FC

For a previously described species: Lectotype male, pinned ... [details] here designated to fix the concept of *X-us albus* Jones and to ensure the universal and consistent interpretation of the same. Or ... [details then] by designation of Smith (1976: 999).

Previously published names: For a **previously published name**, please provide the year of description. Also use the parentheses convention for subsequent new combinations.

[Etymology]

Authors of new species name should state exactly what the epithet is in terms of the ICZN, as outlined in Article 11.9.1.1 to 11.9.1.4 as well as 11.3. A name may be a word in or derived from Latin, Greek or any other language (even one with no alphabet), or be formed from such a word. In short, a name can be declared as arbitrary combination (the best solution) or must be or be treated as:

I) a word of two or more letters, or a compound word, and, if a Latin or latinized word must be, or be treated as:

1. an adjective or participle in the nominative singular (as in *Echinus esculentus*, *Felis marmorata*, *Seioptera vibrans*), or
2. a noun in the nominative singular standing in apposition to the generic name (as in *Struthio camelus*, *Cercopithecus diana*), or
3. a noun in the genitive case (e.g. *rosae*, *sturionis*, *thermopylarum*, *galliae*, *sanctipauli*, *sanctae-helenae*, *cuvieri*, *merianae*, *smithorum*), or
4. an adjective used as a substantive in the genitive case and derived from the specific name of an organism with which the animal in question is associated (as in *Lernaeocera lusci*, a copepod parasitic on *Trisopterus luscus*).

II) An adjectival species-group name proposed in Latin text but written otherwise than in the nominative singular because of the requirements of Latin grammar is available provided that it meets the other requirements of availability, but it is to be corrected to the nominative singular if necessary.

Arranging sections within species treatments (sections in square brackets are requested for new descriptions only!):

[Name]

[Material]

- [Type material]

- Other material

[Diagnosis]

[Description]

[Etymology]

Distribution

Ecology (including phenology)

Conservation status (optional, we encourage authors to follow the IUCN categories and criteria, please see http://www.iucnredlist.org/static/categories_criteria_3_1#critical))

Discussion (optional, but very desirable)

Materials and Methods

In line with responsible and reproducible research, as well as FAIR (Findability, Accessibility, Interoperability and Reusability) data principles, we highly recommend that authors describe in detail and deposit their science methods and laboratory protocols in the open access repository protocols.io.

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Furthermore, an author could open up his/her protocol to the public at the click of a button as soon as their article is published.

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Prepare a detailed protocol via protocols.io.

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Online publishing allows an author to provide data sets, tables, video files, or other information as supplementary information, greatly increasing the impact of the submission. Uploading of such files is possible in Step 4 of the submission process.

The maximum file size for each Supplementary File is 20 MB.

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- Title of data
- Description of data

All supplementary files should be referenced explicitly by file name within the body of the article, e.g. 'See supplementary file 1: Movie 1' for the original data used to perform this analysis.

Ideally, the supplementary files should not be platform-specific, and should be viewable using free or widely available tools. Suitable file formats are:

For supplementary documentation:

- **PDF** (Adobe Acrobat)

For animations:

- **SWF** (Shockwave Flash)

For movies:

- **MOV** (QuickTime)
- **MPG** (MPEG)

For datasets:

- XLS (Excel spreadsheet)
- CSV (Comma separated values)
- ODS (OpenOffice spreadsheets)

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Manuscripts submitted to this journal must be divided into separate files (not larger than 20 MB each) to allow their processing by our software. Before attempting an online submission, please consider preparing the following file types:

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Review version of the manuscript in PDF format, with all figures embedded, total file size not larger than 20 MB

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Original text file and high-resolution figures must be submitted during the same submission process as additional files (Step 6) in one of the accepted file formats (see below). These may be compressed in order to reduce bandwidth during upload:

Text of the manuscript (DOC, DOCX, RTF, OpenDocument Format, ODF) with tables embedded in the text.

Each figure as an individual file in one of the following image file formats: EPS, TIFF, JPEG, PNG, GIF, BMP, not larger than 20 MB each.

Each equation as an individual file in one of the above mentioned image file formats.

3. Supplementary files (appendices)

Large datasets or multimedia files, usually published as appendices in conventional print journals, should be uploaded as supplementary files, completed with associated metadata on the online submission form. Supplementary files should have their own legends and will be referenced as appendices under separate DOI numbers.

Most file formats are accepted. Text-only appendices must be in DOC, DOCX, RTF, or ODF formats. Should you have any technical problems in submitting a manuscript to this journal, please contact the Editorial Office at journals@pensoft.net. We encourage authors to send an enquiry to the respective Subject Editor prior to submitting a manuscript. The purpose of the presubmission enquiry is to solicit rapid initial feedback on the suitability of the manuscript for publication in this journal. Presubmission enquiries may be sent also to the Editorial Office at journals@pensoft.net.

ANEXO II: INSTRUCTIONS TO AUTHORS BIOTA NEOTROPICA

Manuscripts for publication in Biota Neotropica are to be submitted **EXCLUSIVELY** through the website <http://mc04.manuscriptcentral.com/bn-scielo> and must be prepared in accordance with the instructions below. After successful submission you will receive a confirmation email along with an ID number for your paper.

All subsequent correspondence should be sent to the Managing Editor at ea@biotaneotropica.org.br.

Since Biota Neotropica established a partnership with SciELO, the publication fee charged is R\$ 1000.00 (One Thousand Reais) for Brazilian authors or US\$ 400.00 (Four Hundred Dollars) for foreign authors, irrespective of the number of pages published. Payment details will be sent to authors in the final editorial stage of articles accepted for publication. There is no submission fees for the articles.

Biota Neotropica does not publish papers that include description of new species of taxonomic groups which Nomenclatural Code requires printed copies. Authors are responsible to check if the specific requirements of the Nomenclatural Code of the organism they are working with. If your taxonomic group does require printed copies of your publication you should look for another journal to submit your paper.

Biota Neotropica publishes eight types of manuscript: editorial, point of view, articles, thematic reviews, short communications, identification key, inventories and taxonomic reviews. Only the Editorial is written by the Editorial Board or by an invited researcher and is therefore subject to different submission rules.

Manuscripts submitted under any category should be written entirely in English.

The submitting author must provide an ORCID ID (Open Researcher and Contributor ID, <http://orcid.org/>) at the time of submission by entering it in the user profile in the submission system. We strongly encourage coauthors to do the same.

The authors are responsible for presenting the article in good scientific English, and it is strongly recommended that the manuscript undergo a final revision by a specialized

proofreading company such as American Journal Experts/AJE, Nature Publishing Group Language Editing, Edanz and/or other SciELO-approved services. Should the Editorial Board consider the level of English to be below journal standards, the paper may be refused even after approval by the Area Editor. The content of manuscripts accepted for publication, regardless of category, is the sole responsibility of the author(s).

1 – Manuscript Category

To follow is a brief description of how the Editorial Board defines each manuscript category

Editorial

For each issue of *Biota Neotropica*, the Editor-in-Chief may invite a researcher to write an Editorial on relevant topics, from a scientific standpoint and in terms of creating policies for the conservation and sustainable use of biodiversity in the Neotropical region. Editorials should contain a maximum of 3000 words.

Points of View

This section acts as a forum for academic discussion of a relevant issue within the scope of the journal, whereby the researcher will write a short, thought-provoking, article expressing his/her viewpoint on the issue in question. At the discretion of the Editorial Board, the journal may publish responses or considerations of other researchers to stimulate discussion on the issue. The content of manuscripts accepted for publication, regardless of category, is the sole responsibility of the author(s).

Articles

Articles are submitted spontaneously by their authors in the System of Submission of the Journal at <http://mc04.manuscriptcentral.com/bn-scielo>. The manuscript must bring new data, not published or submitted to publication, in part or entirely, in other journals or books, and must be results of research in characterization, conservation, restoration and sustainable use of biodiversity in Neotropical region. The manuscript is expected to discuss an issue of scientific interest within the scope of the journal and include a review of the specialized literature, as well as a discussion of articles recently published in the international literature.

The content of manuscripts accepted for publication, regardless of category, is the sole responsibility of the author(s).

Thematic Reviews

Thematic Reviews are also submitted spontaneously by their authors through the Journal Submission System. The manuscript is expected to develop a scientific concept or theme related to the scope of the journal, based on references that are essential to understanding the subject of the reviews, and including the most recent published articles on the issue. The content of manuscripts accepted for publication, regardless of category, is the sole responsibility of the author(s).

Short Communications

These are short articles submitted spontaneously by their authors. The manuscript must contain new data, not previously published and/or submitted for publication in part or in whole, in any other periodical or book, and be the result of research on the characterization, conservation, restoration or sustainable use of Neotropical biodiversity. The manuscript is expected to briefly discuss a new component among the issues of scientific interest related to the scope of *Biota Neotropica*, based on recently published articles. The content of manuscripts accepted for publication, regardless of category, is the sole responsibility of the author(s).

Papers that only report the occurrence of species in a region where their presence would be expected, but have yet to be recorded, are not published by *Biota Neotropica*.

Identification Keys

Identification Keys are submitted spontaneously by their authors through the Journal Submission System. The manuscript is expected to describe, to the fullest extent possible, the taxonomic group characterized by the identification key. It should be firmly based on the taxonomic literature regarding the group in question. The content of manuscripts accepted for publication, regardless of category, is the sole responsibility of the author(s).

Inventories

Inventories are submitted spontaneously by their authors through the Journal Submission System. The manuscript should contain new data, not previously published and/or submitted for publication in part or in whole, in any other periodical or book, and be the result of research on the characterization, conservation, restoration or sustainable use of Neotropical biodiversity. In addition to the list of inventoried species, the manuscript should include the authors' selection criteria (assemblage, guild, locality etc.), the methodology used and the geographic coordinates of the study area. It must be strongly based on the best taxonomic literature available for the group, and must inform clearly the institution where testimony specimens are deposited. The content of manuscripts accepted for publication, regardless of category, is the sole responsibility of the author(s).

Taxonomic Reviews

Taxonomic Reviews are submitted spontaneously by their authors through the Journal Submission System. The manuscript should contain new data, not previously published and/or submitted for publication in part or in whole, in any other periodical or book, and be the result of research on the characterization, conservation, restoration or sustainable use of Neotropical biodiversity. The manuscript is expected to contain comprehensive information on the taxon under review, elucidate the main taxonomic issues and justify the need to revise it. The review should be based on the current and historical scientific literature regarding the taxon in question, and must inform clearly the institution where the testimony specimens are deposited. The content of manuscripts accepted for publication, regardless of category, is the sole responsibility of the author(s).

2 – Submission and Publishing

After the paper is submitted, manuscripts that meet the guidelines will be sent to the Editor-in-Chief, who will forward them to the Area Editors, who in turn will select at least two “ad hoc” reviewers. In order to minimize conflicts of interest, the journal currently uses the “double-blind” mechanism, where neither authors nor reviewers are identified. This is especially important because the authors are also asked to choose researchers that they do NOT wish to review their manuscript.

The Area Editors are responsible for the entire publishing phase of the manuscript, sending feedback to authors and reformulated versions of the work to the reviewers. Once all requirements and recommendations made by reviewers and the Associate Editors are met, the manuscript is preliminarily accepted and forwarded to the Chief Editor. It is up to the Editor-in-Chief, in common agreement with the Editorial Board, to definitively accept the paper.

The Abstracts of accepted papers are revised by their authors and published online in the current issue of *Biota Neotropica*. It is important that authors submit the definitive version of their work (including text, tables and figures) through the Submission System, incorporating the final alterations/corrections requested by the reviewers and/or Area Editor, since this is the version that will be sent to the Editor-in-Chief for publication. Care taken at this stage significantly reduces the need for corrections/alterations to the article proofs.

Search tools, as well as indexation services, use the words in the title and the keywords to locate and classify an article. Therefore, the selection of keywords ensures that the author's manuscript can be found by other authors interested in the same issue, increasing the likelihood of using their results and, consequently, of citations. The information available at <http://www.editage.com/insights/why-do-journals-ask-for-keywords> is a good source for selecting keywords.

Upon submitting a manuscript to *Biota Neotropica*, the author(s) transfer(s) copyright to the journal. In any subsequent use of parts of the text, figures and tables, *Biota Neotropica* must be cited as the source.

3 – File formatting

The manuscripts should be sent in DOC format (MS-Word for Windows version 6.0 or higher) using Times New Roman font size 10. Section titles must be in font size 12. Bold face, italics, underlines, subscripts and superscripts can be used when pertinent, but excessive use of these resources should be avoided. In special cases (see formulas below), the following fonts can be used: Courier New, Symbol and Wingdings. Manuscripts can contain electronic links that the author judges appropriate. These must be included using the resources available in MS-Word.

After submission, the manuscripts sent to Biota Neotropica must be divided into a file containing the entire text of the manuscript, including the main body of the text (first page, abstract, introduction, materials, methods, results, discussion, acknowledgements and references) and, if necessary, a file for tables. Figures will be included separately and identified in the system. It is essential that authors open the files they prepared for submission to carefully check if the figures, graphs or tables are in the desired format

Main document

A single file (called Principal.doc) containing titles, abstracts and keywords (these are also included in another stage of the submission), entire text of the manuscript, references and tables. The co-authors and their respective affiliations should NOT be included in this file, neither should it contain figures, which must be included separately in the system, as described below. The manuscript should use the following format:

Brief and informative title

Use a capital letter in the first word and in accordance with pre-established grammar or scientific rules.

Body of the Manuscript

a. Sections – must not be numbered

Introduction

Material and Methods

Results

Discussion

Acknowledgments

References

b. Special cases

At the author's discretion, in the case of "Short Communications", Results and Discussion can be combined. Do not use footnotes, include the information directly in the text, since it makes reading easier and reduces the number of electronic links to the manuscript.

In the case of the "Inventories" category, the list of species, environments, descriptions, photos, etc. should be sent separately so that they can be organized in accordance with specific formats. To facilitate the use of search engines, such as XML, the Editorial Board will send the authors specific instructions for formatting the list of species cited in the manuscript.

In the "Identification Keys" category, the key itself should be sent separately so that it can be adequately formatted. In the case of references to material collected, the geographical coordinates of the collection area must be included. Whenever possible, the coordinates should be in degrees, minutes and seconds (for example, 24°32'75" S and 53°06'31" W). In the case of references to endangered species, specify only degrees and minutes.

c. Numbering subtitles

The title of each section should be written without numbering, in boldface, with only the first letter capitalized (Ex. Introduction, Materials and Methods etc.). Only two levels of subtitles, below the title of each section, will be permitted. Subtitles must be numbered in Arabic numerals followed by a period to help identify their order in the final format of the manuscript. Ex. Material and Methods; 1. Subtitle; 1.1. Sub-subtitle.

d. Species names

In the case of species citations, they must comply with the respective Nomenclature Codes. In the area of Zoology, all the species cited in the paper must be followed by the author and date of the original publication of the description, or by the author and/or revisor of the species in the case of Botany. In the field of Microbiology specific sources should be consulted, such as the International Journal of Systematic and Evolutionary Microbiology.

e. References in the text

Insert references in accordance with the following standard:

Silva (1960) or (Silva 1960)

Silva (1960, 1973)

Silva (1960a, b)

Silva & Pereira (1979) or (Silva & Pereira 1979)

Silva et al. (1990) or (Silva et al. 1990)

(Silva 1989, Pereira & Carvalho 1993, Araújo et al. 1996, Lima 1997)

Biota Neotropica does not accept references to unpublished data that are inaccessible to the reviewers or readers. In taxonomic studies, include citations of the material examined in accordance with the specific rules of the type of organism under study.

f. Numbers and units

Present numbers and units as follows:

- numbers up to nine should be spelled out, unless they are followed by units;
- use a period for the decimal number (10.5 m);
- use the International System of Units, separating the value units by a space (except for percentages, degrees, minutes and seconds);
- use unit abbreviations whenever possible. Do not use spaces to change lines if the unit does not fit on the same line.

g. Formulas

Formulas that can be written on a single line, even if it requires the use of special fonts (Symbol, Courier New and Wingdings), can be included in the text. Ex. $a = p.r^2$ or Na_2HPO_4 , etc. Any other type of formula or equation will be considered a figure and must therefore follow the rules established for figures.

h. Figure and Table citations

Write words in full (Ex. Figure 1, Table 1)

i. References

Adopt the format shown in the following examples, including all data requested, in the sequence and with the punctuation indicated, without adding items not mentioned:

FERGUSON, I.B. & BOLLARD, E.G. 1976. The movement of calcium in woody stems. *Ann. Bot.* 40(6):1057-1065.

SMITH, P.M. 1976. The chemotaxonomy of plants. Edward Arnold, London.

SNEDECOR, G.W. & COCHRAN, W.G. 1980. Statistical methods. 7 ed. Iowa State University Press, Ames.

SUNDERLAND, N. 1973. Pollen and anther culture. In *Plant tissue and cell culture* (H.F. Street, ed.). Blackwell Scientific Publications, Oxford, p.205-239.

BENTHAM, G. 1862. Leguminosae. Dalbergiae. In *Flora Brasiliensis* (C.F.P. Martius & A.G. Eichler, eds). F. Fleischer, Lipsiae, v.15, pars 1, p.1-349.

MANTOVANI, W., ROSSI, L., ROMANIUC NETO, S., ASSAD-LUDEWIGS, I.Y., WANDERLEY, M.G.L., MELO, M.M.R.F. & TOLEDO, C.B. 1989. Estudo fitossociológico de áreas de mata ciliar em Mogi-Guaçu, SP, Brasil. In *Simpósio sobre mata ciliar* (L.M. Barbosa, coord.). Fundação Cargil, Campinas, p.235-267.

STRUFFALDI-DE VUONO, Y. 1985. Fitossociologia do estrato arbóreo da floresta da Reserva Biológica do Instituto de Botânica de São Paulo, SP. Tese de doutorado, Universidade de São Paulo, São Paulo.

FISHBASE. <http://www.fishbase.org/home.htm> (last access in dd/mm/aaaa)

Abbreviate periodical titles in accordance with the "World List of Scientific Periodicals" (<http://library.caltech.edu/reference/abbreviations/>) or according to the database of the Catálogo Coletivo Nacional (CCN -IBICT) (search available at <http://ccn.ibict.br/busca.jsf>).

All papers published in Biota Neotropica have an individual electronic address, which appears on the top left area of the PDF, as well as a DOI identification number. Therefore, to reference papers published in Biota Neotropica follow the example below:

SANTOS, R.M., SCHLINDWEIN, M.N., VIVIANI, V.R. Survey of Bioluminescent Coleoptera in the Atlantic Rain Forest of Serra da Paranapiacaba in São Paulo State (Brazil).

Biota Neotropica. 16(1): e0045. <http://dx.doi.org/10.1590/1676-0611-BN-2015-0045> (last access on dd/mm/yyyy)

j. Tables

Tables can be inserted directly into MS Excel software, but must be saved in spreadsheet, not workbook format.

Tables must be numbered sequentially with Arabic numerals.

The legend should be included in this file, contained in a single paragraph, and identified by starting the paragraph with Table N, where N is the number of the table.

k. Figures

Maps, photos and graphs are considered figures. Figures should be numbered sequentially using Arabic numerals.

In the case of drawings, the texts contained in the figures should use sans-serif fonts, such as Arial or Helvetica, for better legibility. Figures composed of several others should be identified by letters (Ex. Figure 1a, Figure 1b). Use a scale bar to indicate size. Figures should not contain legends; these must be included in their own file.

Figure legends should be part of the Principal.rtf or Principal.doc text file, and included after the references. Each legend should be contained in a single paragraph and be identified, starting the paragraph with Figure N, where N is the number of the figure. Compound figures can or not have independent legends.

4 - Authorship

After acknowledgements, create the item Authors' Contributions, containing information about the contribution of each of the authors, which should be described using one of the following:

Substantial contribution in the concept and design of the study;

Contribution to data collection

Contribution to data analysis and interpretation

Contribution to manuscript preparation

Contribution to critical revision, adding intellectual content

The contributions of each co-author be included in the system in order to appear as a note in the published manuscript.

5 – Conflicts of interest

Biota Neotropica requires all authors to explain any potential sources of conflict of interest. Any interest or relationship, financial or otherwise, that could potentially influence the author's objectivity, is considered a potential source of conflict of interest. These must be revealed when they are either directly or indirectly related to the manuscript submitted to the journal. The existence of a conflict of interest does not impede publication in this journal, provided that it is clearly explained by the authors in a footnote or in the acknowledgements.

The corresponding author is responsible for informing all the authors regarding this policy and ensuring that they comply with this guideline.

If the authors have no conflict of interest to declare, they must state the following: “The author(s) declare(s) that they have no conflict of interest related to the publication of this manuscript”.

6 - Ethics

Biota Neotropica is confident that the authors who submit manuscripts have complied with the guidelines established by the ethics committees of their respective research institutions. Studies involving human beings and/or clinical trials must be approved by the Institutional Committee that assesses this type of research. This approval, as well as information on the nature of this Committee, should be included in the Materials and Methods section. In the case of human subjects, it is essential to include a declaration that prior informed consent was obtained from all the participants, or a declaration stating why this was not necessary.

Biota Neotropica uses CrossCheck to identify any sort of plagiarism, double submissions, already published articles and possible frauds in research.

7 – Publication frequency

Biota Neotropica is a quarterly journal that publishes 4 issues a year. The online publication is continuous and the paper is published as soon as the authors approve the final document. An issue is finalized every three months and as such, papers approved by March 31 will be published in issue 1, by June 30 in issue 2, by September 30 in issue 3 and by December 31 in issue 4. The Editorial Board may decide to publish special editions of the journal.

8 – Data availability

Data are an important product of research and must be preserved for decades. Biota Neotropica recommends that the data, or in the case of theoretical studies the mathematical models used, be archived in public data repositories such as the Sistema de Informação Ambiental do Programa Biota/Fapesp/SinBiota, Dryad Digital Repository - Dryad, TreeBASE Web, GenBank, Figshare, Sistema de Informação sobre a Biodiversidade Brasileira/SiBBR or another repository selected by the author, that provides comparable access and guaranteed preservation.

This journal is financed by the BIOTA/FAPESP program of the São Paulo Research Foundation (FAPESP).

ANEXO II: LICENÇA DE COLETA



Autorização para atividades com finalidade científica

Número: 57360-3	Data da Emissão: 15/06/2018 10:44	Data para Revalidação*: 15/07/2019
* De acordo com o art. 28 da IN 03/2014, esta autorização tem prazo de validade equivalente ao previsto no cronograma de atividades do projeto, mas deverá ser revalidada anualmente mediante a apresentação do relatório de atividades a ser enviado por meio do Sisbio no prazo de até 30 dias a contar da data do aniversário de sua emissão.		

Dados do titular

Nome: ÉRICK CRISTÓFORE GUIMARÃES	CPF: 072.722.736-07
Título do Projeto: Estimativas de diversidade, ecologia e conservação da ictiofauna de água doce, de pequeno e médio porte dos Estados do Pará, Maranhão e Piauí	
Nome da Instituição : FUNDAÇÃO UNIVERSIDADE FEDERAL DO MARANHÃO	CNPJ: 06.279.103/0001-19

Cronograma de atividades

#	Descrição da atividade	Início (mês/ano)	Fim (mês/ano)
1	Atualização do conhecimento relativo a diversidade dos peixes de água doce	03/2017	03/2021

Observações e ressalvas

1	As atividades de campo exercidas por pessoa natural ou jurídica estrangeira, em todo o território nacional, que impliquem o deslocamento de recursos humanos e materiais, tendo por objeto coletar dados, materiais, espécimes biológicos e minerais, peças integrantes da cultura nativa e cultura popular, presente e passada, obtidos por meio de recursos e técnicas que se destinem ao estudo, à difusão ou à pesquisa, estão sujeitas a autorização do Ministério de Ciência e Tecnologia.
2	Esta autorização NÃO exime o pesquisador titular e os membros de sua equipe da necessidade de obter as anuências previstas em outros instrumentos legais, bem como do consentimento do responsável pela área, pública ou privada, onde será realizada a atividade, inclusive do órgão gestor de terra indígena (FUNAI), da unidade de conservação estadual, distrital ou municipal, ou do proprietário, arrendatário, posseiro ou morador de área dentro dos limites de unidade de conservação federal cujo processo de regularização fundiária encontra-se em curso.
3	Este documento somente poderá ser utilizado para os fins previstos na Instrução Normativa ICMBio nº 03/2014 ou na Instrução Normativa ICMBio nº 10/2010, no que especifica esta Autorização, não podendo ser utilizado para fins comerciais, industriais ou esportivos. O material biológico coletado deverá ser utilizado para atividades científicas ou didáticas no âmbito do ensino superior.
4	A autorização para envio ao exterior de material biológico não consignado deverá ser requerida por meio do endereço eletrônico www.ibama.gov.br (Serviços on-line - Licença para importação ou exportação de flora e fauna - CITES e não CITES).
5	O titular de licença ou autorização e os membros da sua equipe deverão optar por métodos de coleta e instrumentos de captura direcionados, sempre que possível, ao grupo taxonômico de interesse, evitando a morte ou dano significativo a outros grupos; e empregar esforço de coleta ou captura que não comprometa a viabilidade de populações do grupo taxonômico de interesse em condição in situ.
6	O titular de autorização ou de licença permanente, assim como os membros de sua equipe, quando da violação da legislação vigente, ou quando da inadequação, omissão ou falsa descrição de informações relevantes que subsidiaram a expedição do ato, poderá, mediante decisão motivada, ter a autorização ou licença suspensa ou revogada pelo ICMBio, nos termos da legislação brasileira em vigor.
7	Este documento não dispensa o cumprimento da legislação que dispõe sobre acesso a componente do patrimônio genético existente no território nacional, na plataforma continental e na zona econômica exclusiva, ou ao conhecimento tradicional associado ao patrimônio genético, para fins de pesquisa científica, bioprospecção e desenvolvimento tecnológico. Veja maiores informações em www.mma.gov.br/cgen .
8	Em caso de pesquisa em UNIDADE DE CONSERVAÇÃO, o pesquisador titular desta autorização deverá contactar a administração da unidade a fim de CONFIRMAR AS DATAS das expedições, as condições para realização das coletas e de uso da infra-estrutura da unidade.

Outras ressalvas

1	1. Disponibilizar banco de imagens do trabalho para compor o acervo do Parque; 2. Fornecer um Baner com os resultados do trabalho para apresentação no Parque; 3. Realizar planejamento de logística de campo conjunto a equipe gestora do PNCM, para garantir segurança e minimização de conflitos pelas coletas em propriedades privadas no interior da UC.
2	Disponibilizar publicações e dados relacionados a pesquisa na unidade e comunicar as incursões de pesquisa no interior da UC.

Equipe

#	Nome	Função	CPF	Doc. Identidade	Nacionalidade
1	Felipe Polivanov Ottoni	Participante	100.743.197-01	20668918-4 Detran-RJ	Brasileira
2	PAMELLA SILVA DE BRITO	Participante	039.796.233-94	21108632002-2 SSP-MA	Brasileira

Locais onde as atividades de campo serão executadas

Este documento (Autorização para atividades com finalidade científica) foi expedido com base na Instrução Normativa nº 03/2014. Através do código de autenticação abaixo, qualquer cidadão poderá verificar a autenticidade ou regularidade deste documento, por meio da página do Sisbio/ICMBio na Internet (www.icmbio.gov.br/sisbio).

Código de autenticação: 75951877





Autorização para atividades com finalidade científica

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* De acordo com o art. 28 da IN 03/2014, esta autorização tem prazo de validade equivalente ao previsto no cronograma de atividades do projeto, mas deverá ser revalidada anualmente mediante a apresentação do relatório de atividades a ser enviado por meio do Sisbio no prazo de até 30 dias a contar da data do aniversário de sua emissão.		

Dados do titular

Nome: ÉRICK CRISTÓFORE GUIMARÃES	CPF: 072.722.736-07
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Nome da Instituição : FUNDAÇÃO UNIVERSIDADE FEDERAL DO MARANHÃO	CNPJ: 06.279.103/0001-19

#	Município	UF	Descrição do local	Tipo
1		PA	Estado do Pará	Fora de UC Federal
2		MA	Estado do Maranhão	Fora de UC Federal
3		PI	Estado do Piauí	Fora de UC Federal

Atividades X Táxons

#	Atividade	Táxons
1	Coleta/transporte de espécimes da fauna silvestre in situ	Actinopterygii (*Qtde: 50)

* Quantidade de indivíduos por espécie, por localidade ou unidade de conservação, a serem coletados durante um ano.

Material e métodos

1	Método de captura/coleta (Peixes)	Puçá, Rede de emalhar (emalhe de deriva, de fundo, malhadeiras, caceio, feiteiras, tresmalhos e caçoeira), Rede de arrasto de meia-água (tração motorizada), Armadilha (covo, manzuá, potes para polvos, substrato específico, manilha e variações), Garatêia (jig) de mão, Captura manual, Peneira, Tarrafa, Picaré, Coleta manual
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Destino do material biológico coletado

#	Nome local destino	Tipo Destino
1	FUNDAÇÃO UNIVERSIDADE FEDERAL DO MARANHÃO	coleção

Este documento (Autorização para atividades com finalidade científica) foi expedido com base na Instrução Normativa nº 03/2014. Através do código de autenticação abaixo, qualquer cidadão poderá verificar a autenticidade ou regularidade deste documento, por meio da página do Sisbio/ICMBio na Internet (www.icmbio.gov.br/sisbio).

Código de autenticação: 75951877





Autorização para atividades com finalidade científica

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Nome da Instituição : FUNDAÇÃO UNIVERSIDADE FEDERAL DO MARANHÃO	CNPJ: 06.279.103/0001-19

Registro de coleta imprevista de material biológico

De acordo com a Instrução Normativa nº 03/2014, a coleta imprevista de material biológico ou de substrato não contemplado na autorização ou na licença permanente deverá ser anotada na mesma, em campo específico, por ocasião da coleta, devendo esta coleta imprevista ser comunicada por meio do relatório de atividades. O transporte do material biológico ou do substrato deverá ser acompanhado da autorização ou da licença permanente com a devida anotação. O material biológico coletado de forma imprevista, deverá ser destinado à instituição científica e, depositado, preferencialmente, em coleção biológica científica registrada no Cadastro Nacional de Coleções Biológicas (CCBIO).

Táxon*	Qtde.	Tipo de amostra	Qtde.	Data

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Autorização para atividades com finalidade científica

Número: 57360-3	Data da Emissão: 15/06/2018 10:44	Data para Revalidação*: 15/07/2019
* De acordo com o art. 28 da IN 03/2014, esta autorização tem prazo de validade equivalente ao previsto no cronograma de atividades do projeto, mas deverá ser revalidada anualmente mediante a apresentação do relatório de atividades a ser enviado por meio do Sisbio no prazo de até 30 dias a contar da data do aniversário de sua emissão.		

Dados do titular

Nome: ÉRICK CRISTÓFORE GUIMARÃES	CPF: 072.722.736-07
Título do Projeto: Estimativas de diversidade, ecologia e conservação da ictiofauna de água doce, de pequeno e médio porte dos Estados do Pará, Maranhão e Piauí	
Nome da Instituição : FUNDAÇÃO UNIVERSIDADE FEDERAL DO MARANHÃO	CNPJ: 06.279.103/0001-19

* Identificar o espécime no nível taxonômico possível.

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Código de autenticação: 75951877





Autorização para atividades com finalidade científica

Número: 57414-3	Data da Emissão: 18/06/2018 10:28	Data para Revalidação*: 18/07/2019
* De acordo com o art. 28 da IN 03/2014, esta autorização tem prazo de validade equivalente ao previsto no cronograma de atividades do projeto, mas deverá ser revalidada anualmente mediante a apresentação do relatório de atividades a ser enviado por meio do Sisbio no prazo de até 30 dias a contar da data do aniversário de sua emissão.		

Dados do titular

Nome: ÉRICK CRISTÓFORE GUIMARÃES	CPF: 072.722.736-07
Título do Projeto: Estudo taxonômico e estimativa de diversidade da família Characidae	
Nome da Instituição : FUNDAÇÃO UNIVERSIDADE FEDERAL DO MARANHÃO	CNPJ: 06.279.103/0001-19

Cronograma de atividades

#	Descrição da atividade	Início (mês/ano)	Fim (mês/ano)
1	Coleta, transporte e identificação taxonômica das espécies	03/2017	03/2021

Observações e ressalvas

1	As atividades de campo exercidas por pessoa natural ou jurídica estrangeira, em todo o território nacional, que impliquem o deslocamento de recursos humanos e materiais, tendo por objeto coletar dados, materiais, espécimes biológicos e minerais, peças integrantes da cultura nativa e cultura popular, presente e passada, obtidos por meio de recursos e técnicas que se destinem ao estudo, à difusão ou à pesquisa, estão sujeitas a autorização do Ministério de Ciência e Tecnologia.
2	Esta autorização NÃO exige o pesquisador titular e os membros de sua equipe da necessidade de obter as anuências previstas em outros instrumentos legais, bem como do consentimento do responsável pela área, pública ou privada, onde será realizada a atividade, inclusive do órgão gestor de terra indígena (FUNAI), da unidade de conservação estadual, distrital ou municipal, ou do proprietário, arrendatário, possessor ou morador de área dentro dos limites de unidade de conservação federal cujo processo de regularização fundiária encontra-se em curso.
3	Este documento somente poderá ser utilizado para os fins previstos na Instrução Normativa ICMBio nº 03/2014 ou na Instrução Normativa ICMBio nº 10/2010, no que especifica esta Autorização, não podendo ser utilizado para fins comerciais, industriais ou esportivos. O material biológico coletado deverá ser utilizado para atividades científicas ou didáticas no âmbito do ensino superior.
4	A autorização para envio ao exterior de material biológico não consignado deverá ser requerida por meio do endereço eletrônico www.ibama.gov.br (Serviços on-line - Licença para importação ou exportação de flora e fauna - CITES e não CITES).
5	O titular de licença ou autorização e os membros da sua equipe deverão optar por métodos de coleta e instrumentos de captura direcionados, sempre que possível, ao grupo taxonômico de interesse, evitando a morte ou dano significativo a outros grupos; e empregar esforço de coleta ou captura que não comprometa a viabilidade de populações do grupo taxonômico de interesse em condição in situ.
6	O titular de autorização ou de licença permanente, assim como os membros de sua equipe, quando da violação da legislação vigente, ou quando da inadequação, omissão ou falsa descrição de informações relevantes que subsidiaram a expedição do ato, poderá, mediante decisão motivada, ter a autorização ou licença suspensa ou revogada pelo ICMBio, nos termos da legislação brasileira em vigor.
7	Este documento não dispensa o cumprimento da legislação que dispõe sobre acesso a componente do patrimônio genético existente no território nacional, na plataforma continental e na zona econômica exclusiva, ou ao conhecimento tradicional associado ao patrimônio genético, para fins de pesquisa científica, bioprospecção e desenvolvimento tecnológico. Veja maiores informações em www.mma.gov.br/cgen .
8	Em caso de pesquisa em UNIDADE DE CONSERVAÇÃO, o pesquisador titular desta autorização deverá contactar a administração da unidade a fim de CONFIRMAR AS DATAS das expedições, as condições para realização das coletas e de uso da infra-estrutura da unidade.

Equipe

#	Nome	Função	CPF	Doc. Identidade	Nacionalidade
1	ARIEL GUILHERME SANTOS DO NASCIMENTO	Coleta e Auxílio na triagem	085.382.996-97	15479043 SSP-MG	Brasileira
2	PÂMELLA SILVA DE BRITO	Coleta e Identificação taxonômica	039.796.233-94	21108632002-2 SSP-MA	Brasileira
3	Felipe Polivanov Ottoni	Coleta e Identificação taxonômica	100.743.197-01	20668918-4 Detran-RJ	Brasileira

Locais onde as atividades de campo serão executadas

#	Município	UF	Descrição do local	Tipo
1		AC	Acre	Fora de UC Federal
2		AL	Alagoas	Fora de UC Federal
3		AP	Amapá	Fora de UC Federal
4		AM	Amazonas	Fora de UC Federal
5		BA	Bahia	Fora de UC Federal
6		CE	Ceará	Fora de UC Federal

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Código de autenticação: 73622244





Autorização para atividades com finalidade científica

Número: 57414-3	Data da Emissão: 18/06/2018 10:28	Data para Revalidação*: 18/07/2019
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Dados do titular

Nome: ÉRICK CRISTÓFORE GUIMARÃES	CPF: 072.722.736-07
Título do Projeto: Estudo taxonômico e estimativa de diversidade da família Characidae	
Nome da Instituição : FUNDAÇÃO UNIVERSIDADE FEDERAL DO MARANHÃO	CNPJ: 06.279.103/0001-19

7	DF	Distrito Federal	Fora de UC Federal
8	ES	Espírito Santo	Fora de UC Federal
9	GO	Goiás	Fora de UC Federal
10	MA	Maranhão	Fora de UC Federal
11	MT	Mato Grosso	Fora de UC Federal
12	MS	Mato Grosso do Sul	Fora de UC Federal
13	MG	Minas Gerais	Fora de UC Federal
14	PA	Pará	Fora de UC Federal
15	PB	Paraíba	Fora de UC Federal
16	TO	Tocantins	Fora de UC Federal
17	PR	Paraná	Fora de UC Federal
18	RJ	Rio de Janeiro	Fora de UC Federal
19	SP	São Paulo	Fora de UC Federal
20	PI	Piauí	Fora de UC Federal
21	PE	Pernambuco	Fora de UC Federal
22	SE	Sergipe	Fora de UC Federal
23	RO	Rondonia	Fora de UC Federal

Atividades X Táxons

#	Atividade	Táxons
1	Coleta/transporte de espécimes da fauna silvestre in situ	Characidae (*Qtde: 20)

* Quantidade de indivíduos por espécie, por localidade ou unidade de conservação, a serem coletados durante um ano.

Material e métodos

1	Método de captura/coleta (Peixes)	Rede de plâncton, Anzol e linha (op.manual):linha de mão,de corso,carretilha,molinete,corrico,vara e isca viva, Artes fixas (gamboa, curral e variações), Puçá, Rede de arrasto de meia-água (tração motorizada), Pesca elétrica, Peneira, Rede de arrasto de praia: cerco de praia (tração manual), Rede de emalhar (emalhe de deriva, de fundo, malhadeiras, caceio, feiteiras,tresmalhos e caçoeira), Armadilha (covo, manzuá, potes para polvos, substrato específico, manilha e variações), Tarrafa, Picaré, Coleta manual, Captura manual
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Destino do material biológico coletado

#	Nome local destino	Tipo Destino
1	FUNDAÇÃO UNIVERSIDADE FEDERAL DO MARANHÃO	colecção

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Autorização para atividades com finalidade científica

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Dados do titular

Nome: ÉRICK CRISTÓFORE GUIMARÃES	CPF: 072.722.736-07
Título do Projeto: Estudo taxonômico e estimativa de diversidade da família Characidae	
Nome da Instituição : FUNDAÇÃO UNIVERSIDADE FEDERAL DO MARANHÃO	CNPJ: 06.279.103/0001-19

Registro de coleta imprevista de material biológico

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Táxon*	Qtde.	Tipo de amostra	Qtde.	Data

* Identificar o espécime no nível taxonômico possível.

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Código de autenticação: 73622244





Autorização para atividades com finalidade científica

Número: 57787-1	Data da Emissão: 08/03/2017 11:31	Data para Revalidação*: 07/04/2018
* De acordo com o art. 28 da IN 03/2014, esta autorização tem prazo de validade equivalente ao previsto no cronograma de atividades do projeto, mas deverá ser revalidada anualmente mediante a apresentação do relatório de atividades a ser enviado por meio do Sisbio no prazo de até 30 dias a contar da data do aniversário de sua emissão.		

Dados do titular

Nome: Felipe Polivanov Ottoni	CPF: 100.743.197-01
Título do Projeto: Estimativas de diversidade, ecologia e conservação da Ictiofauna de água doce e estuarina Neotropical	
Nome da Instituição : FUNDAÇÃO UNIVERSIDADE FEDERAL DO MARANHÃO	CNPJ: 06.279.103/0001-19

Cronograma de atividades

#	Descrição da atividade	Início (mês/ano)	Fim (mês/ano)
1	coleta de material	03/2017	02/2022

Observações e ressalvas

1	As atividades de campo exercidas por pessoa natural ou jurídica estrangeira, em todo o território nacional, que impliquem o deslocamento de recursos humanos e materiais, tendo por objeto coletar dados, materiais, espécimes biológicos e minerais, peças integrantes da cultura nativa e cultura popular, presente e passada, obtidos por meio de recursos e técnicas que se destinem ao estudo, à difusão ou à pesquisa, estão sujeitas a autorização do Ministério de Ciência e Tecnologia.
2	Esta autorização NAO exige o pesquisador titular e os membros de sua equipe da necessidade de obter as anuências previstas em outros instrumentos legais, bem como do consentimento do responsável pela área, pública ou privada, onde será realizada a atividade, inclusive do órgão gestor de terra indígena (FUNAI), da unidade de conservação estadual, distrital ou municipal, ou do proprietário, arrendatário, posseiro ou morador de área dentro dos limites de unidade de conservação federal cujo processo de regularização fundiária encontra-se em curso.
3	Este documento somente poderá ser utilizado para os fins previstos na Instrução Normativa ICMBio nº 03/2014 ou na Instrução Normativa ICMBio nº 10/2010, no que especifica esta Autorização, não podendo ser utilizado para fins comerciais, industriais ou esportivos. O material biológico coletado deverá ser utilizado para atividades científicas ou didáticas no âmbito do ensino superior.
4	A autorização para envio ao exterior de material biológico não consignado deverá ser requerida por meio do endereço eletrônico www.ibama.gov.br (Serviços on-line - Licença para importação ou exportação de flora e fauna - CITES e não CITES).
5	O titular de licença ou autorização e os membros da sua equipe deverão optar por métodos de coleta e instrumentos de captura direcionados, sempre que possível, ao grupo taxonômico de interesse, evitando a morte ou dano significativo a outros grupos; e empregar esforço de coleta ou captura que não comprometa a viabilidade de populações do grupo taxonômico de interesse em condição in situ.
6	O titular de autorização ou de licença permanente, assim como os membros de sua equipe, quando da violação da legislação vigente, ou quando da inadequação, omissão ou falsa descrição de informações relevantes que subsidiaram a expedição do ato, poderá, mediante decisão motivada, ter a autorização ou licença suspensa ou revogada pelo ICMBio, nos termos da legislação brasileira em vigor.
7	Este documento não dispensa o cumprimento da legislação que dispõe sobre acesso a componente do patrimônio genético existente no território nacional, na plataforma continental e na zona econômica exclusiva, ou ao conhecimento tradicional associado ao patrimônio genético, para fins de pesquisa científica, bioprospecção e desenvolvimento tecnológico. Veja maiores informações em www.mma.gov.br/cgen .
8	Em caso de pesquisa em UNIDADE DE CONSERVAÇÃO, o pesquisador titular desta autorização deverá contactar a administração da unidade a fim de CONFIRMAR AS DATAS das expedições, as condições para realização das coletas e de uso da infra-estrutura da unidade.

Equipe

#	Nome	Função	CPF	Doc. Identidade	Nacionalidade
1	Elionenai da Silva Oliveira	coletor	607.872.063-50	041912612011-1 dic-MA	Brasileira
2	Shyrley Glenda de Sousa Viana	coletora	048.804.441-38	3127178 ssp-DF	Brasileira
3	Axel Makay Katz	coletor e pesquisador	122.132.327-09	202879524 DETRAN-RJ	Brasileira
4	Rozijane Santos Fernandes	coletora	999.808.603-59	104333499-5 SPC-MA	Brasileira
5	Pedro Henrique Negreiros de Bragança	coletor e pesquisador	124.505.037-06	217455799 DIC-RJ	Brasileira
6	PÂMELLA SILVA DE BRITO	coletora e pesquisadora	039.796.233-94	21108632002-2 SSP-MA	Brasileira
7	DIEGO SOUSA CAMPOS	coletor	033.849.253-43	262481220036 GEJUSPC-MA-MA	Brasileira
8	Elisabeth Henschel de Lima Costa	coletora	142.499.487-06	214895831 DETRAN-RJ	Brasileira
9	PEDRO FASURA DE AMORIM	coletor e pesquisador	122.572.417-11	257907923 DETRAN-RJ	Brasileira
10	ÉRICK CRISTÓFORE GUIMARÃES	coletor e pesquisador	072.722.736-07	MG14.553.646 SSP-MG	Brasileira
1	Olivia Alves de Sousa	coletora	047.623.763-70	0354944620084 ssp-MA	Brasileira

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Autorização para atividades com finalidade científica

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Dados do titular

Nome: Felipe Polivanov Ottoni	CPF: 100.743.197-01
Título do Projeto: Estimativas de diversidade, ecologia e conservação da Ictiofauna de água doce e estuarina Neotropical	
Nome da Instituição : FUNDAÇÃO UNIVERSIDADE FEDERAL DO MARANHÃO	CNPJ: 06.279.103/0001-19

Locais onde as atividades de campo serão executadas

#	Município	UF	Descrição do local	Tipo
1		AC	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
2		AL	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
3		AP	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
4		AM	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
5		BA	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
6		CE	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
7		DF	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
8		ES	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
9		GO	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
10		MA	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
11		MA	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
12		MT	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
13		MS	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
14		MG	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
15		MG	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
16		PA	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
17		PB	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
18		PR	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
19		PE	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
20		BA	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
21		PI	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
22		RJ	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
23		RN	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
24		RS	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
25		MT	Rios, riachos, lagos, lagoas e alagados	Fora de UC Federal
26		MS	Rios, riachos, agos, lagoas e alagados	Fora de UC Federal
27		RS	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
28		RO	Rios, riachos, lagos, lagoas e alagados	Fora de UC Federal
29		SC	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
30		SP	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
31		SE	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
32		TO	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
33		TO	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
34		PE	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
35		PB	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
36		AL	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal
37		SE	Rios, riachos, estuários, lagos, lagoas e alagados	Fora de UC Federal

Atividades X Táxons

#	Atividade	Táxons
1	Captura de animais silvestres in situ	Scorpaeniformes, Characiformes, Gymnotiformes, Torpedinidae, Blenniidae, Cyprinodontiformes, Perciformes, Pleuronectiformes, Siluriformes, Potamotrygonidae, Cichlidae, Gobiidae, Syngnathidae, Eleotridae, Tetraodontiformes

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Código de autenticação: 17533676





Autorização para atividades com finalidade científica

Número: 57787-1	Data da Emissão: 08/03/2017 11:31	Data para Revalidação*: 07/04/2018
* De acordo com o art. 28 da IN 03/2014, esta autorização tem prazo de validade equivalente ao previsto no cronograma de atividades do projeto, mas deverá ser revalidada anualmente mediante a apresentação do relatório de atividades a ser enviado por meio do Sisbio no prazo de até 30 dias a contar da data do aniversário de sua emissão.		

Dados do titular

Nome: Felipe Polivanov Ottoni	CPF: 100.743.197-01
Título do Projeto: Estimativas de diversidade, ecologia e conservação da Ictiofauna de água doce e estuarina Neotropical	
Nome da Instituição : FUNDAÇÃO UNIVERSIDADE FEDERAL DO MARANHÃO	CNPJ: 06.279.103/0001-19

2	Coleta/transporte de espécimes da fauna silvestre in situ	Perciformes (*Qtde: 50), Cyprinodontiformes (*Qtde: 50), Gobiidae (*Qtde: 20), Gymnotiformes (*Qtde: 50), Tetraodontiformes (*Qtde: 15), Torpedinidae (*Qtde: 10), Cichlidae (*Qtde: 50), Potamotrygonidae (*Qtde: 15), Scorpaeniformes (*Qtde: 20), Siluriformes (*Qtde: 50), Blenniidae (*Qtde: 20), Syngnathidae (*Qtde: 20), Eleotridae (*Qtde: 30), Characiformes (*Qtde: 50), Pleuronectiformes (*Qtde: 15)
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* Quantidade de indivíduos por espécie, por localidade ou unidade de conservação, a serem coletados durante um ano.

Material e métodos

1	Método de captura/coleta (Peixes)	Peneira, Armadilha (covo, manzuá, potes para polvos, substrato específico, manilha e variações), Coleta manual, Picaré, Rede de emalhar (emalhe de deriva, de fundo, malhadeiras, caceio, feiteiras, tresmalhos e caçoeira), Puçá, Tarrafa, Captura manual
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Destino do material biológico coletado

#	Nome local destino	Tipo Destino
1	FUNDAÇÃO UNIVERSIDADE FEDERAL DO MARANHÃO	coleção

Este documento (Autorização para atividades com finalidade científica) foi expedido com base na Instrução Normativa nº 03/2014. Através do código de autenticação abaixo, qualquer cidadão poderá verificar a autenticidade ou regularidade deste documento, por meio da página do Sisbio/ICMBio na Internet (www.icmbio.gov.br/sisbio).

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Dados do titular

Nome: Felipe Polivanov Ottoni	CPF: 100.743.197-01
Título do Projeto: Estimativas de diversidade, ecologia e conservação da Ictiofauna de água doce e estuarina Neotropical	
Nome da Instituição : FUNDAÇÃO UNIVERSIDADE FEDERAL DO MARANHÃO	CNPJ: 06.279.103/0001-19

Registro de coleta imprevista de material biológico

De acordo com a Instrução Normativa nº 03/2014, a coleta imprevista de material biológico ou de substrato não contemplado na autorização ou na licença permanente deverá ser anotada na mesma, em campo específico, por ocasião da coleta, devendo esta coleta imprevista ser comunicada por meio do relatório de atividades. O transporte do material biológico ou do substrato deverá ser acompanhado da autorização ou da licença permanente com a devida anotação. O material biológico coletado de forma imprevista, deverá ser destinado à instituição científica e, depositado, preferencialmente, em coleção biológica científica registrada no Cadastro Nacional de Coleções Biológicas (CCBIO).

Táxon*	Qtde.	Tipo de amostra	Qtde.	Data

* Identificar o espécime no nível taxonômico possível.

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Autorização para atividades com finalidade científica

Número: 54949-2	Data da Emissão: 07/04/2017 09:54	Data para Revalidação*: 07/05/2018
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Dados do titular

Nome: Felipe Polivanov Ottoni	CPF: 100.743.197-01
Título do Projeto: Estudos ecológicos e de distribuição de peixes teleosteos do Estado do Maranhão, Pará e Piauí	
Nome da Instituição : FUNDAÇÃO UNIVERSIDADE FEDERAL DO MARANHÃO	CNPJ: 06.279.103/0001-19

Cronograma de atividades

#	Descrição da atividade	Início (mês/ano)	Fim (mês/ano)
1	atividade de pesquisa	07/2016	07/2021

Observações e ressalvas

1	As atividades de campo exercidas por pessoa natural ou jurídica estrangeira, em todo o território nacional, que impliquem o deslocamento de recursos humanos e materiais, tendo por objeto coletar dados, materiais, espécimes biológicos e minerais, peças integrantes da cultura nativa e cultura popular, presente e passada, obtidos por meio de recursos e técnicas que se destinem ao estudo, à difusão ou à pesquisa, estão sujeitas a autorização do Ministério de Ciência e Tecnologia.
2	Esta autorização NAO exige o pesquisador titular e os membros de sua equipe da necessidade de obter as anuências previstas em outros instrumentos legais, bem como do consentimento do responsável pela área, pública ou privada, onde será realizada a atividade, inclusive do órgão gestor de terra indígena (FUNAI), da unidade de conservação estadual, distrital ou municipal, ou do proprietário, arrendatário, posseiro ou morador de área dentro dos limites de unidade de conservação federal cujo processo de regularização fundiária encontra-se em curso.
3	Este documento somente poderá ser utilizado para os fins previstos na Instrução Normativa ICMBio nº 03/2014 ou na Instrução Normativa ICMBio nº 10/2010, no que especifica esta Autorização, não podendo ser utilizado para fins comerciais, industriais ou esportivos. O material biológico coletado deverá ser utilizado para atividades científicas ou didáticas no âmbito do ensino superior.
4	A autorização para envio ao exterior de material biológico não consignado deverá ser requerida por meio do endereço eletrônico www.ibama.gov.br (Serviços on-line - Licença para importação ou exportação de flora e fauna - CITES e não CITES).
5	O titular de licença ou autorização e os membros da sua equipe deverão optar por métodos de coleta e instrumentos de captura direcionados, sempre que possível, ao grupo taxonômico de interesse, evitando a morte ou dano significativo a outros grupos; e empregar esforço de coleta ou captura que não comprometa a viabilidade de populações do grupo taxonômico de interesse em condição in situ.
6	O titular de autorização ou de licença permanente, assim como os membros de sua equipe, quando da violação da legislação vigente, ou quando da inadequação, omissão ou falsa descrição de informações relevantes que subsidiaram a expedição do ato, poderá, mediante decisão motivada, ter a autorização ou licença suspensa ou revogada pelo ICMBio, nos termos da legislação brasileira em vigor.
7	Este documento não dispensa o cumprimento da legislação que dispõe sobre acesso a componente do patrimônio genético existente no território nacional, na plataforma continental e na zona econômica exclusiva, ou ao conhecimento tradicional associado ao patrimônio genético, para fins de pesquisa científica, bioprospecção e desenvolvimento tecnológico. Veja maiores informações em www.mma.gov.br/cgen .
8	Em caso de pesquisa em UNIDADE DE CONSERVAÇÃO, o pesquisador titular desta autorização deverá contactar a administração da unidade a fim de CONFIRMAR AS DATAS das expedições, as condições para realização das coletas e de uso da infra-estrutura da unidade.

Outras ressalvas

1	1. Sejam fornecidas imagens no formato digital das espécies para compor o banco de dados da UC; 2. Seja fornecido um Baner ao final do trabalho com os resultados para exposição na UC.
2	São condições para a realização da pesquisa: 1- O pesquisador deve apresentar, previamente aos trabalhos de campo, sua pesquisa às comunidades residentes; 2- As atividades de pesquisa não devem interferir nas atividades locais; 3- Ao final da pesquisa, os resultados devem ser apresentados à comunidade.
3	Recomenda-se efetuar as coletas que ocorrerão com a rede de emalhar no ambiente Costeiro Marinho (estuários e manguezais) do Pará e Maranhão com verificação constante de captura (máximo de 6 horas - período de entre-maré) para evitar mortalidade de espécies ameaçadas como <i>Epinephelus itajara</i> ou <i>Pristis pectinata</i> .
4	Aponto como ressalva que a pesquisa seja apresentada no conselho gestor da unidade e nele discutida sua execução; que sejam desenvolvidas junto as famílias da Resex ações educativas relativas aos temas e assuntos relacionados a pesquisa, com finalidade de socialização do conhecimento aos beneficiários da Resex; que os conhecimentos gerados com a pesquisa sejam retornados à Unidade em linguagem e formato adequado a compreensão das famílias; e que os equipamentos e materiais utilizados na coleta dos dados sejam recolhidos após sua conclusão.
5	Apresentar as coordenadas das cavidades estudadas

Equipe

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Autorização para atividades com finalidade científica

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Dados do titular

Nome: Felipe Polivanov Ottoni	CPF: 100.743.197-01
Título do Projeto: Estudos ecológicos e de distribuição de peixes teleosteos do Estado do Maranhão, Pará e Piauí	
Nome da Instituição : FUNDAÇÃO UNIVERSIDADE FEDERAL DO MARANHÃO	CNPJ: 06.279.103/0001-19

#	Nome	Função	CPF	Doc. Identidade	Nacionalidade
1	Filipe da Silva Rangel Pereira	coletor	138.215.627-81	209050657 DETRAN-RJ	Brasileira
2	ERICK CRISTOFORO GUIMARAES	coletor e pesquisador	072.722.736-07	MG14.553.646 SSP-MG	Brasileira
3	DIEGO SOUSA CAMPOS	coletor e pesquisador	033.849.253-43	262481220036 GEJUSPC-MA-MA	Brasileira
4	Elisabeth Henschel de Lima Costa	coletora	142.499.487-06	214895831 DETRAN-RJ	Brasileira
5	Pedro Henrique Negreiros de Bragança	coletor	124.505.037-06	217455799 DIC-RJ	Brasileira
6	Axel Makay Katz	coletor	122.132.327-09	202879524 DETRAN-RJ	Brasileira
7	PAMELLA SILVA DE BRITO	coletora e pesquisadora	039.796.233-94	21108632002-2 SSP-MA	Brasileira
8	Elioenai da Silva Oliveira	coletor	607.872.063-50	041912612011-1 dic-MA	Brasileira
9	Rozijane Santos Fernandes	coletora	999.808.603-59	104333499-5 SPC-MA	Brasileira
10	Olivia Alves de Sousa	coletora	047.623.763-70	0354944620084 ssp-MA	Brasileira
11	Shyrley Glenda de Sousa Viana	coletora	048.804.441-38	3127178 ssp-DF	Brasileira

Locais onde as atividades de campo serão executadas

#	Município	UF	Descrição do local	Tipo
1		MA	Rios, riachos, alagados, lagos e brejos	Fora de UC Federal
2		MA	Rios, riachos, alagados, lagos e brejos	Fora de UC Federal
3		MA	Rios, riachos, alagados, lagos e brejos	Fora de UC Federal
4		MA	Área costeira	Fora de UC Federal
5		MA	RESERVA EXTRATIVISTA CHAPADA LIMPA	UC Federal
6		MA	PARQUE NACIONAL DA CHAPADA DAS MESAS	UC Federal
7		MA	ÁREA DE PROTEÇÃO AMBIENTAL DELTA DO PARNAIBA	UC Federal
8		MA	PARQUE NACIONAL DAS NASCENTES DO RIO PARNAIBA	UC Federal
9		MA	PARQUE NACIONAL DOS LENÇÓIS MARANHENSES	UC Federal
10		MA	RESERVA BIOLÓGICA DO GURUPI	UC Federal
11		MA	RESERVA EXTRATIVISTA DO CIRIACO	UC Federal
12		MA	RESERVA EXTRATIVISTA MARINHA DO DELTA DO PARNAIBA	UC Federal
13		MA	RESERVA EXTRATIVISTA QUILOMBO DO FLEXAL	UC Federal
14		MA	RESERVA EXTRATIVISTA DE CURURUPU	UC Federal
15		MA	RESERVA EXTRATIVISTA MATA GRANDE	UC Federal
16		MA	ÁREA DE PROTEÇÃO AMBIENTAL SERRA DA TABATINGA	UC Federal
17		PI	rios, riachos, lagos, alagados, brejos e estuários	Fora de UC Federal
18		PI	rios, riachos, lagos, alagados, brejos e estuários	Fora de UC Federal
19		PA	rios, riachos, lagos, alagados, brejos e estuários	Fora de UC Federal
20		PA	estuários e prais	Fora de UC Federal
21		MA	praias, costões e estuários	Fora de UC Federal

Atividades X Táxons

#	Atividade	Táxons
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Dados do titular

Nome: Felipe Polivanov Ottoni	CPF: 100.743.197-01
Título do Projeto: Estudos ecológicos e de distribuição de peixes teleosteos do Estado do Maranhão, Pará e Piauí	
Nome da Instituição : FUNDAÇÃO UNIVERSIDADE FEDERAL DO MARANHÃO	CNPJ: 06.279.103/0001-19

1	Coleta/transporte de espécimes da fauna silvestre in situ	Mugiliformes (*Qtde: 50), Beloniformes (*Qtde: 50), Characiformes (*Qtde: 150), Gasterosteiformes (*Qtde: 50), Pleuronectiformes (*Qtde: 50), Synbranchiformes (*Qtde: 50), Anguilliformes (*Qtde: 50), Lophiiformes (*Qtde: 150), Osteoglossiformes (*Qtde: 20), Cyprinodontiformes (*Qtde: 150), Clupeiformes (*Qtde: 150), Gymnotiformes (*Qtde: 150), Tetraodontiformes (*Qtde: 55), Atheriniformes (*Qtde: 50), Siluriformes (*Qtde: 150), Perciformes (*Qtde: 150), Scorpaeniformes (*Qtde: 50), Syngnathiformes (*Qtde: 50)
2	Observação e gravação de imagem ou som de taxon em UC federal	Beloniformes, Cyprinodontiformes, Mugiliformes, Perciformes, Atheriniformes, Siluriformes, Gasterosteiformes, Lophiiformes, Clupeiformes, Osteoglossiformes, Scorpaeniformes, Pleuronectiformes, Syngnathiformes, Characiformes, Synbranchiformes, Tetraodontiformes, Anguilliformes, Gymnotiformes

* Quantidade de indivíduos por espécie, por localidade ou unidade de conservação, a serem coletados durante um ano.

Material e métodos

1	Método de captura/coleta (Peixes)	Peneira, Coleta manual, Puçá, Picaré, Rede de emalhar (emalhe de deriva, de fundo, malhadeiras, caceio, feitiças, tresmalhos e caçoeira), Armadilha (covo, manzuá, potes para polvos, substrato específico, manilha e variações), Tarrafa
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Destino do material biológico coletado

#	Nome local destino	Tipo Destino
1	FUNDAÇÃO UNIVERSIDADE FEDERAL DO MARANHÃO	coleção

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Dados do titular

Nome: Felipe Polivanov Ottoni	CPF: 100.743.197-01
Título do Projeto: Estudos ecológicos e de distribuição de peixes teleósteos do Estado do Maranhão, Pará e Piauí	
Nome da Instituição : FUNDAÇÃO UNIVERSIDADE FEDERAL DO MARANHÃO	CNPJ: 06.279.103/0001-19

Registro de coleta imprevista de material biológico

De acordo com a Instrução Normativa nº 03/2014, a coleta imprevista de material biológico ou de substrato não contemplado na autorização ou na licença permanente deverá ser anotada na mesma, em campo específico, por ocasião da coleta, devendo esta coleta imprevista ser comunicada por meio do relatório de atividades. O transporte do material biológico ou do substrato deverá ser acompanhado da autorização ou da licença permanente com a devida anotação. O material biológico coletado de forma imprevista, deverá ser destinado à instituição científica e, depositado, preferencialmente, em coleção biológica científica registrada no Cadastro Nacional de Coleções Biológicas (CCBIO).

Táxon*	Qtde.	Tipo de amostra	Qtde.	Data

* Identificar o espécime no nível taxonômico possível.

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Autorização para atividades com finalidade científica

Número: 51540-3	Data da Emissão: 20/04/2017 14:11	Data para Revalidação*: 20/05/2018
* De acordo com o art. 28 da IN 03/2014, esta autorização tem prazo de validade equivalente ao previsto no cronograma de atividades do projeto, mas deverá ser revalidada anualmente mediante a apresentação do relatório de atividades a ser enviado por meio do Sisbio no prazo de até 30 dias a contar da data do aniversário de sua emissão.		

Dados do titular

Nome: Felipe Polivanov Ottoni	CPF: 100.743.197-01
Título do Projeto: Estimativas de diversidade e conservação da ictiofauna de água doce, de pequeno e médio porte dos Estados do Ceará, Pará, Maranhão e Piauí	
Nome da Instituição : FUNDAÇÃO UNIVERSIDADE FEDERAL DO MARANHÃO	CNPJ: 06.279.103/0001-19

Cronograma de atividades

#	Descrição da atividade	Início (mês/ano)	Fim (mês/ano)
1	coletas e pesquisas	10/2015	10/2019

Observações e ressalvas

1	As atividades de campo exercidas por pessoa natural ou jurídica estrangeira, em todo o território nacional, que impliquem o deslocamento de recursos humanos e materiais, tendo por objeto coletar dados, materiais, espécimes biológicos e minerais, peças integrantes da cultura nativa e cultura popular, presente e passada, obtidos por meio de recursos e técnicas que se destinem ao estudo, à difusão ou à pesquisa, estão sujeitas a autorização do Ministério de Ciência e Tecnologia.
2	Esta autorização NÃO exige o pesquisador titular e os membros de sua equipe da necessidade de obter as anuências previstas em outros instrumentos legais, bem como do consentimento do responsável pela área, pública ou privada, onde será realizada a atividade, inclusive do órgão gestor de terra indígena (FUNAI), da unidade de conservação estadual, distrital ou municipal, ou do proprietário, arrendatário, posseiro ou morador de área dentro dos limites de unidade de conservação federal cujo processo de regularização fundiária encontra-se em curso.
3	Este documento somente poderá ser utilizado para os fins previstos na Instrução Normativa ICMBio nº 03/2014 ou na Instrução Normativa ICMBio nº 10/2010, no que especifica esta Autorização, não podendo ser utilizado para fins comerciais, industriais ou esportivos. O material biológico coletado deverá ser utilizado para atividades científicas ou didáticas no âmbito do ensino superior.
4	A autorização para envio ao exterior de material biológico não consignado deverá ser requerida por meio do endereço eletrônico www.ibama.gov.br (Serviços on-line - Licença para importação ou exportação de flora e fauna - CITES e não CITES).
5	O titular de licença ou autorização e os membros da sua equipe deverão optar por métodos de coleta e instrumentos de captura direcionados, sempre que possível, ao grupo taxonômico de interesse, evitando a morte ou dano significativo a outros grupos; e empregar esforço de coleta ou captura que não comprometa a viabilidade de populações do grupo taxonômico de interesse em condição in situ.
6	O titular de autorização ou de licença permanente, assim como os membros de sua equipe, quando da violação da legislação vigente, ou quando da inadequação, omissão ou falsa descrição de informações relevantes que subsidiaram a expedição do ato, poderá, mediante decisão motivada, ter a autorização ou licença suspensa ou revogada pelo ICMBio, nos termos da legislação brasileira em vigor.
7	Este documento não dispensa o cumprimento da legislação que dispõe sobre acesso a componente do patrimônio genético existente no território nacional, na plataforma continental e na zona econômica exclusiva, ou ao conhecimento tradicional associado ao patrimônio genético, para fins de pesquisa científica, bioprospecção e desenvolvimento tecnológico. Veja maiores informações em www.mma.gov.br/cgen .
8	Em caso de pesquisa em UNIDADE DE CONSERVAÇÃO, o pesquisador titular desta autorização deverá contactar a administração da unidade a fim de CONFIRMAR AS DATAS das expedições, as condições para realização das coletas e de uso da infra-estrutura da unidade.

Outras ressalvas

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Código de autenticação: 87925244





Autorização para atividades com finalidade científica

Número: 51540-3	Data da Emissão: 20/04/2017 14:11	Data para Revalidação*: 20/05/2018
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Dados do titular

Nome: Felipe Polivanov Ottoni	CPF: 100.743.197-01
Título do Projeto: Estimativas de diversidade e conservação da ictiofauna de água doce, de pequeno e médio porte dos Estados do Ceará, Pará, Maranhão e Piauí	
Nome da Instituição : FUNDAÇÃO UNIVERSIDADE FEDERAL DO MARANHÃO	CNPJ: 06.279.103/0001-19

1	PARNA da Serra da Capivara: Considerando as pequenas dimensões e volume dos reservatórios de água e baixo número de espécimes da ictiofauna na unidade, não será permitido/aconselhável o uso de picaré ou rede de arrasto. Também não será possível aprovar o esforço de coleta proposto pelo pesquisador pela própria insuficiência de exemplares de peixes. O pesquisador deverá usar de bom senso, capturando um número adequado de animais, de forma a não causar nenhum impacto sobre as espécies encontradas nos reservatórios e fontes de água naturais da unidade, no máximo 5-10 espécimes/espécie. O pesquisador deverá ser acompanhado por mateiro/conductor indicado pela chefia da UC durante suas visitas de campo/coletas. O Pesquisador deverá retirar todo material/equipamento quando do término de cada coleta. RESEX Chapada Limpa: Anteriormente ao início das coletas a pesquisa e deverá ser apresentada e discutida no conselho gestor, momento que serão acordados os detalhes desta ressalva: deverão ser desenvolvidas junto as comunidades atividades educativas sobre o assunto pesquisado; ao final do estudo o conhecimento gerado deverá retornar às comunidades e à gestão da RESEX, em material adequado a esse público; todos os equipamentos utilizados deverão ser retirados da UC após as coletas, a fim de não provocar danos ambientais; as coletas deverão ser acompanhadas de um comunitário visando o compartilhamento de conhecimentos e procedimentos. Observa-se que outros estudos do pesquisador foram autorizados nos últimos anos para realização na RESEX, sem que até o momento o pesquisado tenha contado a gestão da UC. RESEX Marinha do Delta do Parnaíba: São condições para a realização da pesquisa: 1- O pesquisador deve apresentar, previamente aos trabalhos de campo, sua pesquisa às comunidades residentes; 2- As atividades de pesquisa não devem interferir nas atividades locais; 3- Ao final da pesquisa, os resultados devem ser apresentados à comunidade. CR 5 (Parnaíba): O projeto deverá ser submetido aos conselhos das RESEX envolvidas, destaque que na FLONA de Palmares não existe nenhum corpo d'água nem dentro nem no seu entorno, mas a mesma dispõe de estrutura para apoio a pesquisadores.
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Equipe

#	Nome	Função	CPF	Doc. Identidade	Nacionalidade
1	bruna tássia dos santos pantoja	coletora	063.381.933-62	0416747020114 ssp-MA	Brasileira
2	MARIA ANAIS BARBOSA SEGADAS VIANNA	coletora	344.322.057-68	3134680-2 IFP-RJ	Brasileira
3	Pedro Henrique Negreiros de Bragança	Coletor	124.505.037-06	217455799 DIC-RJ	Brasileira
4	Axel Makay Katz	coletor	122.132.327-09	202879524 DETRAN-RJ	Brasileira
5	PEDRO FASURA DE AMORIM	coletor	122.572.417-11	257907923 DETRAN-RJ	Brasileira
6	Rozijane Santos Fernandes	coletora	999.808.603-59	104333499-5 SPC-MA	Brasileira
7	ÉRICK CRISTOFRE GUIMARAES	coletor	072.722.736-07	MG14.553.646 SSP-MG	Brasileira
8	DIEGO SOUSA CAMPOS	coletor	033.849.253-43	262481220036 GEJUSPC-MA-MA	Brasileira
9	Elioenai da Silva Oliveira	coletor	607.872.063-50	041912612011-1 dic-MA	Brasileira
10	Elisabeth Henschel de Lima Costa	coletor	142.499.487-06	214895831 DETRAN-RJ	Brasileira
11	PÂMELLA SILVA DE BRITO	coletora e pesquisadora	039.796.233-94	21108632002-2 SSP-MA	Brasileira
12	Olivia Alves de Sousa	coletora	047.623.763-70	0354944620084 ssp-MA	Brasileira
13	Shyrley Glenda de Sousa Viana	coletora	048.804.441-38	3127178 ssp-DF	Brasileira
14	Filipe da Silva Rangel Pereira	coletor	138.215.627-81	209050657 DETRAN-RJ	Brasileira

Locais onde as atividades de campo serão executadas

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#	Município	UF	Descrição do local	Tipo
1		MA	ÁREA DE PROTEÇÃO AMBIENTAL DELTA DO PARNAIBA	UC Federal
2		MA	ÁREA DE PROTEÇÃO AMBIENTAL SERRA DA IBIAPABA	UC Federal
3		MA	ÁREA DE PROTEÇÃO AMBIENTAL SERRA DA TABATINGA	UC Federal
4		MA	PARQUE NACIONAL DA CHAPADA DAS MESAS	UC Federal
5		MA	PARQUE NACIONAL DAS NASCENTES DO RIO PARNAIBA	UC Federal
6		MA	PARQUE NACIONAL DOS LENÇÓIS MARANHENSES	UC Federal
7		MA	RESERVA BIOLÓGICA DO GURUPI	UC Federal
8		MA	RESERVA EXTRATIVISTA DO CIRIACO	UC Federal
9		MA	RESERVA EXTRATIVISTA MARINHA DO DELTA DO PARNAIBA	UC Federal
10		MA	RESERVA EXTRATIVISTA MATA GRANDE	UC Federal
11		MA	RESERVA EXTRATIVISTA QUILOMBO DO FLEXAL	UC Federal
12		PI	ÁREA DE PROTEÇÃO AMBIENTAL CHAPADA DO ARARIPE	UC Federal
13		PI	ÁREA DE PROTEÇÃO AMBIENTAL DELTA DO PARNAIBA	UC Federal
14		PI	ÁREA DE PROTEÇÃO AMBIENTAL SERRA DA IBIAPABA	UC Federal
15		PI	ÁREA DE PROTEÇÃO AMBIENTAL SERRA DA TABATINGA	UC Federal
16		PI	ESTAÇÃO ECOLÓGICA DE URUÇUI-UNA	UC Federal
17		PI	FLORESTA NACIONAL DE PALMARES	UC Federal
18		PI	PARQUE NACIONAL DA SERRA DA CAPIVARA	UC Federal
19		PI	PARQUE NACIONAL DAS NASCENTES DO RIO PARNAIBA	UC Federal
20		PI	RESERVA EXTRATIVISTA MARINHA DO DELTA DO PARNAIBA	UC Federal
21		PI	PARQUE NACIONAL DA SERRA DAS CONFUSÕES	UC Federal
22		MA	RESERVA EXTRATIVISTA CHAPADA LIMPA	UC Federal
23		CE	Rios, riachos, alagados e lagoas	Fora de UC Federal
24		CE	ÁREA DE PROTEÇÃO AMBIENTAL CHAPADA DO ARARIPE	UC Federal
25		CE	ÁREA DE PROTEÇÃO AMBIENTAL DELTA DO PARNAIBA	UC Federal
26		CE	ÁREA DE PROTEÇÃO AMBIENTAL SERRA DA IBIAPABA	UC Federal
27		CE	ÁREA DE PROTEÇÃO AMBIENTAL SERRA DA MERUOCA	UC Federal
28		CE	ESTAÇÃO ECOLÓGICA DE AIUABA	UC Federal
29		CE	ESTAÇÃO ECOLÓGICA DO CASTANHO	UC Federal
30		CE	FLORESTA NACIONAL DE ARARIPE-APODI	UC Federal
31		CE	FLORESTA NACIONAL DE SOBRAL	UC Federal
32		CE	PARQUE NACIONAL DE JERICOACOARA	UC Federal
33		CE	PARQUE NACIONAL DE UBAJARA	UC Federal
34		CE	RESERVA EXTRATIVISTA DO BATOQUE	UC Federal
35		MA	Rio, riachos, brejos, lagoas e alagados	Fora de UC Federal
36		MA	Rio, riachos, brejos, lagoas e alagados	Fora de UC Federal
37		PI	Rio, riachos, brejos, lagoas e alagados	Fora de UC Federal
38		PI	Rio, riachos, brejos, lagoas e alagados	Fora de UC Federal
39		PI	Rio, riachos, brejos, lagoas e alagados	Fora de UC Federal
40		PA	rios, riachos, estuários, brejos, lagos e alagados	Fora de UC Federal
41		PI	estuários	Fora de UC Federal
42		CE	estuários	Fora de UC Federal
43		MA	estuários	Fora de UC Federal
44		MA	estuários	Fora de UC Federal

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Atividades X Táxons

#	Atividade	Táxons
1	Coleta/transporte de espécimes da fauna silvestre in situ	Syngnathidae (*Qtde: 30), Eleotridae (*Qtde: 50), Engraulidae (*Qtde: 50), Clupeidae (*Qtde: 50), Tetraodontiformes (*Qtde: 20), Citharinidae (*Qtde: 50), Callichthyidae (*Qtde: 50), Crenuchidae (*Qtde: 50), Lebiasinidae (*Qtde: 50), Prochilodontidae (*Qtde: 50), Distichodontidae (*Qtde: 50), Osteoglossidae (*Qtde: 50), Nandidae (*Qtde: 50), Pimelodidae (*Qtde: 50), Plotosidae (*Qtde: 50), Poeciliidae (*Qtde: 50), Cranoglanididae (*Qtde: 50), Chilodontidae (*Qtde: 50), Cynodontidae (*Qtde: 50), Nematogenyidae (*Qtde: 50), Apterodontidae (*Qtde: 50), Alestidae (*Qtde: 50), Acestrorhynchidae (*Qtde: 50), Anablepidae (*Qtde: 50), Ariidae (*Qtde: 50), Aspredinidae (*Qtde: 50), Astrolepididae (*Qtde: 50), Auchenipteridae (*Qtde: 50), Alestiidae (*Qtde: 50), Amphiliidae (*Qtde: 50), Cetopsidae (*Qtde: 50), Characidae (*Qtde: 50), Cichlidae (*Qtde: 50), Gasteropelecidae (*Qtde: 50), Gasterosteidae (*Qtde: 50), Gobiidae (*Qtde: 50), Gymnotidae (*Qtde: 50), Hemiodontidae (*Qtde: 50), Hepsetidae (*Qtde: 50), Heptapteridae (*Qtde: 50), Hypopomidae (*Qtde: 50), Erythrinidae (*Qtde: 50), Parodontidae (*Qtde: 50), Siluridae (*Qtde: 50), Sternopygidae (*Qtde: 50), Trichomycteridae (*Qtde: 50), Anostomidae (*Qtde: 50), Ctenoluciidae (*Qtde: 50), Curimatidae (*Qtde: 50), Loricariidae (*Qtde: 50), Pseudopimelodidae (*Qtde: 50), Rhamphichthyidae (*Qtde: 50), Rivulidae (*Qtde: 50), Sciaenidae (*Qtde: 50), Scoloplacidae (*Qtde: 50), Serrasalminidae (*Qtde: 50), Belontiiformes (*Qtde: 30), Torpedinidae (*Qtde: 10), Atheriniformes (*Qtde: 30), Mugilidae (*Qtde: 30), Siluriformes (*Qtde: 50), Doradidae (*Qtde: 50), Synbranchidae (*Qtde: 50), Pleuronectiformes (*Qtde: 20), Rajidae (*Qtde: 10), Cyprinodontiformes (*Qtde: 100), Characiformes (*Qtde: 50), Blenniidae (*Qtde: 50), Potamotrygonidae (*Qtde: 10)
2	Observação e gravação de imagem ou som de taxon em UC federal	Rivulidae, Rhamphichthyidae, Pseudopimelodidae, Cichlidae, Cranoglanididae, Astrolepididae, Crenuchidae, Erythrinidae, Gasteropelecidae, Gasterosteidae, Gobiidae, Hemiodontidae, Hypopomidae, Lebiasinidae, Nematogenyidae, Osteoglossidae, Plotosidae, Poeciliidae, Sciaenidae, Prochilodontidae, Sternopygidae, Amphiliidae, Ariidae, Nandidae, Siluridae, Doradidae, Alestidae, Alestiidae, Anablepidae, Anostomidae, Apterodontidae, Auchenipteridae, Callichthyidae, Cetopsidae, Characidae, Chilodontidae, Citharinidae, Parodontidae, Trichomycteridae, Serrasalminidae, Scoloplacidae, Acestrorhynchidae, Aspredinidae, Ctenoluciidae, Curimatidae, Cynodontidae, Distichodontidae, Gymnotidae, Hepsetidae, Heptapteridae, Loricariidae, Pimelodidae, Eleotridae, Tetraodontiformes, Engraulidae, Potamotrygonidae, Siluriformes, Pleuronectiformes, Mugilidae, Characiformes, Rajidae, Synbranchidae, Cyprinodontiformes, Blenniidae, Syngnathidae, Clupeidae, Torpedinidae

* Quantidade de indivíduos por espécie, por localidade ou unidade de conservação, a serem coletados durante um ano.

Material e métodos

1	Método de captura/coleta (Peixes)	Picaré, Peneira, Puçá, Tarrafa
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Destino do material biológico coletado

#	Nome local destino	Tipo Destino
1	UFRJ - UNIVERSIDADE FEDERAL DO RIO DE JANEIRO	coleção
2	FUNDAÇÃO UNIVERSIDADE FEDERAL DO MARANHÃO	coleção

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Registro de coleta imprevista de material biológico

De acordo com a Instrução Normativa nº 03/2014, a coleta imprevista de material biológico ou de substrato não contemplado na autorização ou na licença permanente deverá ser anotada na mesma, em campo específico, por ocasião da coleta, devendo esta coleta imprevista ser comunicada por meio do relatório de atividades. O transporte do material biológico ou do substrato deverá ser acompanhado da autorização ou da licença permanente com a devida anotação. O material biológico coletado de forma imprevista, deverá ser destinado à instituição científica e, depositado, preferencialmente, em coleção biológica científica registrada no Cadastro Nacional de Coleções Biológicas (CCBIO).

Táxon*	Qtde.	Tipo de amostra	Qtde.	Data

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* Identificar o espécime no nível taxonômico possível.

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