

## DOES *Notarius bonillai* (SILURIFORMES: ARIIDAE) OCCUR IN FRESHWATERS AND ESTUARINE IN ILHA DO MARANHÃO, BRAZIL?

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### ABSTRACT

This paper deals with the occurrence of the species *Notarius bonillai* (Miles, 1945) in waters of Ilha do Maranhão (or Ilha de São Luís), Maranhão, Brazil. The investigation is necessary to clarify the distribution of this species before any regional study on it can be made. In seven previous studies, *Notarius bonillai* is mentioned as living in waters of this region: in São José Bay in the east, São Marcos Bay in the west, and Arraial bay in the south. However, several studies in South America report the species as endemic of the two rivers and their estuaries, which flow into the coast of the Caribbean Sea of Colombia. Analysis included preserved specimens identified as *Notarius bonillai* from a regional fish collection of Ilha do Maranhão. Additional material of *Cathorops* specimens were collected in the municipality of Raposa, located near estuary of rio Paciência in the east of Ilha do Maranhão. Analysis of the morphological characteristics of preserved specimens of the regional fish collection, indicate that the species identified as *Notarius bonillai* in the region was erroneously identified, instead being *Cathorops arenatus* (Valenciennes, 1840). Morphological analysis of the additional material collected from *Cathorops* specimens indicate three species of *Cathorops* occurring in Ilha do Maranhão: *Cathorops agassizii* (Eigenmann & Eigenmann, 1888), *Cathorops arenatus* (Valenciennes, 1840), and *Cathorops spixii* (Agassiz, 1829). Consequently, *Notarius bonillai* does not occur in Ilha do Maranhão.

**Key words:** Estuaries, Nueva Granada sea catfish, bagre cabezón, uriacica, São Marcos Bay, São José Bay.

### RESUMO

Este trabalho trata da ocorrência da espécie *Notarius bonillai* (Miles, 1945) na Ilha do Maranhão (ou Ilha de São Luís), Maranhão, Brasil. A investigação é necessária para esclarecer a distribuição desta espécie antes que qualquer estudo regional sobre ela possa ser feito. Em sete estudos anteriores, *Notarius bonillai* é mencionado como vivendo nas águas desta região: na Baía de São José a leste, na Baía de São Marcos a oeste e na Baía de Arraial ao sul. No entanto, vários estudos na América do Sul relatam a espécie como endêmica de dois rios e seus estuários, que desembocam na costa do Mar do Caribe na Colômbia. Análises incluíram espécimes preservados como *Notarius bonillai* de uma coleção regional de peixes da Ilha do Maranhão. Material adicional de espécimes de *Cathorops* foram coletados no município de Raposa, localizado próximo ao estuário do rio Paciência, no leste da Ilha do Maranhão. A análise dos caracteres morfológicos dos espécimes preservados na coleção regional de peixes, indicam que a espécie identificada como *Notarius bonillai* na região foi erroneamente identificada, sendo *Cathorops arenatus* (Valenciennes, 1840) sua correta identificação. Análises morfológicas do material adicional de espécimes de *Cathorops* coletados indicam três espécies de *Cathorops* com ocorrência na Ilha do Maranhão: *Cathorops agassizii* (Eigenmann & Eigenmann, 1888), *Cathorops arenatus* (Valenciennes, 1840) e *Cathorops spixii* (Agassiz, 1829). Consequentemente, *Notarius bonillai* não ocorre na Ilha do Maranhão.

**Palavras-chave:** Estuários, Nueva Granada sea catfish, bagre cabezón, uriacica, Baía de São Marcos, Baía de São José.

## INTRODUCTION

In recent studies (Aguiar-Santos *et al.* 2018, Silva *et al.* 2018), it was reported the occurrence of *Notarius bonillai* (Miles, 1945) in São Marcos Bay, an estuarine complex located at east of the Ilha do Maranhão, northeastern Brazil. In previous studies Soares *et al.* (2011) and Silva Júnior *et al.* (2013) reported this species in the estuary of the rio Paciência, at east, and Castro *et al.* (2010) reported in the area south of the Ilha do Maranhão. However, several studies in South America report the species as endemic to the two rivers and their estuaries, which flow into the coast of the Caribbean Sea of Colombia (Dahl 1971, Marceniuk & Ferraris 2003, Ferraris 2007, Acero & Betancur-R 2006, Acero 2012, Montoya-López *et al.* 2013).

*Notarius bonillai* is an ariid catfish that inhabit fresh and estuarine habitats (Acero 2012). It was originally described by Miles (1945) as *Galeichthys bonillai*, based on a specimen captured in Honda (Colombia), and apparently its neotype was lost (Mojica & Agudelo-Zamora 2018). According to Acero & Betancur-R (2006), Acero *et al.* (2017) and Marceniuk *et al.* (2017), in studies carried out in the Caribbean region, the Nueva Granada sea catfish was erroneously recognized during the late twentieth century, in other ariid genera: *Ariopsis bonillai* (*e.g.*, Taylor & Menezes 1978, Galvis 1984, Cervigón *et al.* 1992, Acero 2003, Ferraris 2007), *Arius bonillai* (Burgess 1989, Acero 1996), *Hexanematichthys bonillai* (Marceniuk & Ferraris 2003) or *Sciades bonillai* (Marceniuk & Menezes 2007).

Marceniuk *et al.* (2017) reviewed the species of the genus *Ariopsis* and described two new species. One of them is the species *Ariopsis canteri*, a catfish of the Caribbean region (coast of Colombia in Western Atlantic), occurring in marine and brackish waters and it rarely enters freshwaters. These authors further states that *A. canteri* is the valid name of the endemic catfish commonly known as “Nueva Granada sea catfish”, “bagre cazón” or “chivo cabezón” and is currently listed as endangered (Acero *et al.* 2017). *Notarius bonillai*, commonly known in the Caribbean region as “bagre de río” or “bagre blanco” is a ariid catfish restricted to Madalena and Atrato rivers basins, draining to the Colombian Caribbean (Acero & Betancur-R 2006, Acero 2012). Considering the importance of the taxonomic description of the species for the region, the aim of this study was to evaluate the occurrence of *Notarius bonillai* in fresh and estuarine waters of Ilha do Maranhão (or Ilha de São Luís), Maranhão, Brazil, based on the analysis of the morphological

characters of the specimens collected and deposited in a regional fish collection, with the hypothesis that the records for this region are imprecise.

## MATERIALS AND METHODS

In the laboratory the species were identified using the descriptions and identification keys proposed by Acero (2003), Marceniuk (2007) and Marceniuk *et al.* (2012). Analysis included specimens preserved in the Fish Collection of the Federal University of Maranhão (Coleção de Peixes da Universidade Federal do Maranhão-CPUFMA). Additional material included specimens collected between July and August 2018 at the fishing terminal in the municipality of Raposa (2°25'1”S, 44°6'21”W), located in East of Ilha do Maranhão. The morphological characters of the species *Notarius bonillai* and *Ariopsis canteri*, were compared with *Cathorops* species analyzed using the descriptions proposed by Miles (1945), Acero & Betancur-R (2006) and Marceniuk *et al.* (2017). After analyzing the morphological characters, tissue samples of the specimens collected were deposited in the Collection of Tissues and DNA from Maranhão Fauna (Coleção de Tecidos e DNA da Fauna Maranhense-CoFauMA), State University of Maranhão (UEMA). All specimens analyzed were measured (total length, Lt or standard length, Ls) in millimeters (mm).

## RESULTS AND DISCUSSION

Field collections were conducted near the estuary of the rio Paciência in the east of Ilha do Maranhão, through conversations with local fishermen, the specimens were collected based on the popular name “uriacica”, because it’s mentioned in the bibliographies of the region for the species *Notarius bonillai* (Barbosa & Nascimento 2009, SEMA 2010). A total of twenty specimens were collected from the field.

Based on observations and analysis of the morphological characters of five specimens deposited in the CPUFMA as *Notarius bonillai*, we verified they were erroneously identified, and were instead *Cathorops arenatus* (Valenciennes, 1840).

Twenty-five specimens were analyzed, representing a total of three species: *Cathorops spixii* (Agassiz, 1829), *Cathorops agassizii* (Eigenmann & Eigenmann, 1888) and *Cathorops arenatus* (Valenciennes, 1840). Our results are based on the comparison of *Cathorops arenatus* with the other *Cathorops* species present in Ilha do Maranhão (*C. agassizii* and *C. spixii*), and *N. bonillai* and *A.*

*canteri*, endemic catfishes from the Caribbean region of Colombia.

### Catalog of species:

In this section “material deposited” indicates specimens collected in field in the present study and “material examined” indicates specimens analyzed during our visit to CPUFMA. The diagnosis of species were based on the descriptions and diagnosis of the papers of Miles (1945), Acero & Betancur-R (2006), Marceniuk (2007), Marceniuk *et al.* (2012) and Marceniuk *et al.* (2017).

#### *Cathorops spixii* (Agassiz, 1829) (Fig. 1a)

English name: madamango sea catfish; Portuguese name: uriacica-amarelo; Spanish name: bagre cuinche

**Material deposited:** CoFauMA CMICs01 (2, Ls 90–154 mm), Brazil, Maranhão: Ilha do

Maranhão, Raposa, Fish Market, 31 Jul. 2018. CoFauMA CMICs02 (7, Ls 138–172 mm), Brazil, Maranhão: Ilha do Maranhão, Raposa, Fish Market, 30 Aug. 2018. CoFauMA CMICs03 (4, Ls 136–175 mm), Brazil, Maranhão: Ilha do Maranhão, Raposa, Fish Market, 31 Aug. 2018.

#### *Cathorops agassizii* (Eigenmann & Eigenmann, 1888) (Fig. 1b)

English name: gaviota sea catfish; Portuguese name: uriacica-branco; Spanish name: bagre cuinche de río

**Material deposited:** CoFauMA CMICag01 (1, Ls 125 mm), Brazil, Maranhão: Ilha do Maranhão, Raposa, Fish Market, 31 Jul. 2018.

#### *Cathorops arenatus* (Valenciennes, 1840) (Fig. 1c)

English name: yellow sea catfish; Portuguese name: uriacica-amarelo, Spanish name: bagre cuinche amarillo

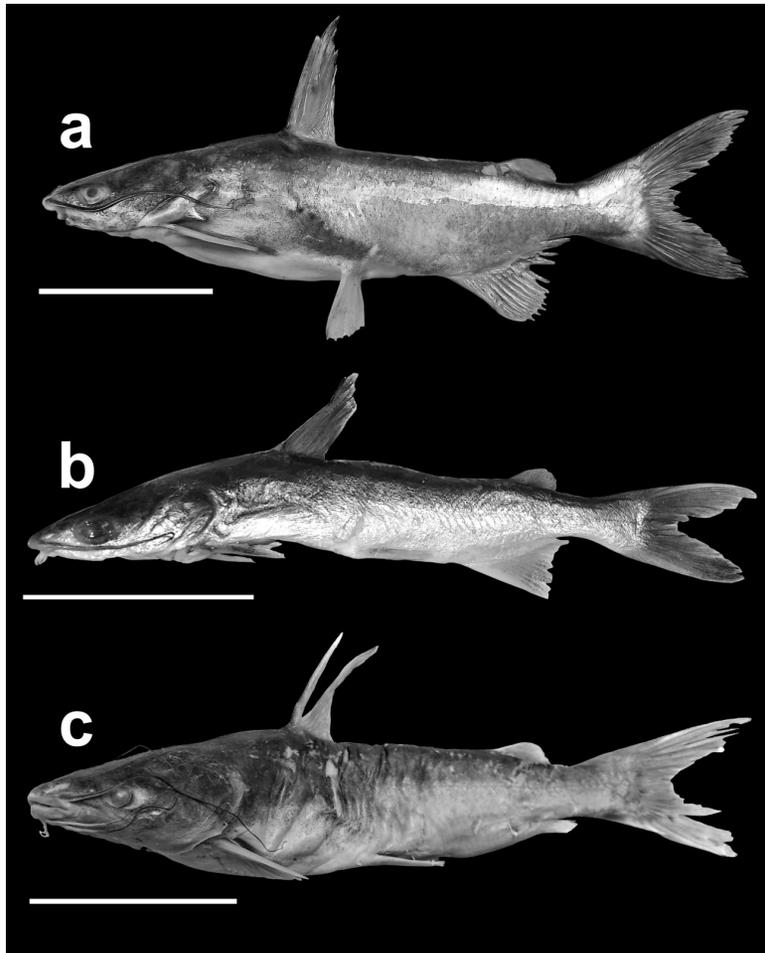


Figure 1. Body in lateral view of *Cathorops* species. (a) *Cathorops spixii*, 204 mm Lt; (b) *Cathorops agassizii* 158 mm Lt; (c) *Cathorops arenatus*, CPUFMA 11871, 175 mm Lt. Scale bars = 50 mm.

**Material deposited:** CoFauMA CMICar01 (3, Ls 127-179 mm), Brazil, Maranhão: Ilha do Maranhão, Raposa, Fish Market, 31 Jul. 2018. CoFauMA CMICar02 (3, Ls 119-174 mm), Brazil, Maranhão: Ilha do Maranhão, Raposa, Fish Market, 30 Aug. 2018.

**Material examined:** The following 5 specimens examined were labeled as *Notarius bonillai*, all were reidentified as *Cathorops arenatus*: CPUFMA 11871 (5, Ls 121.67-143.64 mm), Brazil, Maranhão: São Luís, Baía de São Marcos, Igarapé Buenos Aires/Cabeceira, Oct. 2011.

**Diagnosis of species:** Comparing the species *Cathorops arenatus* and *Cathorops agassizii*, the former differs from the latter, since *C. arenatus* presents long maxillary barbels, exceeding of the pectoral fin bases, while *C. agassizii* has short maxillary barbels, hardly reaching the pectoral-fin bases. The species can also be further differentiated from *C. agassizii* as follows: lips thick, with

the lower lip thicker than the upper lip (vs. lips relatively thick, with the upper lip thicker than lower lip); eyes small, 3.1-4.5% of Ls (vs. eyes large, 4.7-7.1% of Ls). *Cathorops arenatus* can be differentiated from *Cathorops spixii* by having 39-40 free vertebrae (vs. 41-42), and orbital diameter 4.2-6.0 (rarely 4.1) in width of cephalic shield in the supracleithrum area (vs. 2.8-4.1). Compared to the species *Cathorops spixii* and *C. agassizii*, the species *C. arenatus* differs from the other two because is the dorsomedial groove of the neurocranium short and narrow on median portion (vs. long dorsomedial groove, and broader in the median portion) (Fig. 2a-c). Finally, when *Cathorops* spp. is compared to the species *Ariopsis canteri* and *Notarius bonillai*, the former differs mainly because it has only the accessory tooth plates in the palate region, and it does not have vomerine tooth plates (Fig. 3a-c), while the two others have both accessory and vomerine tooth plates.

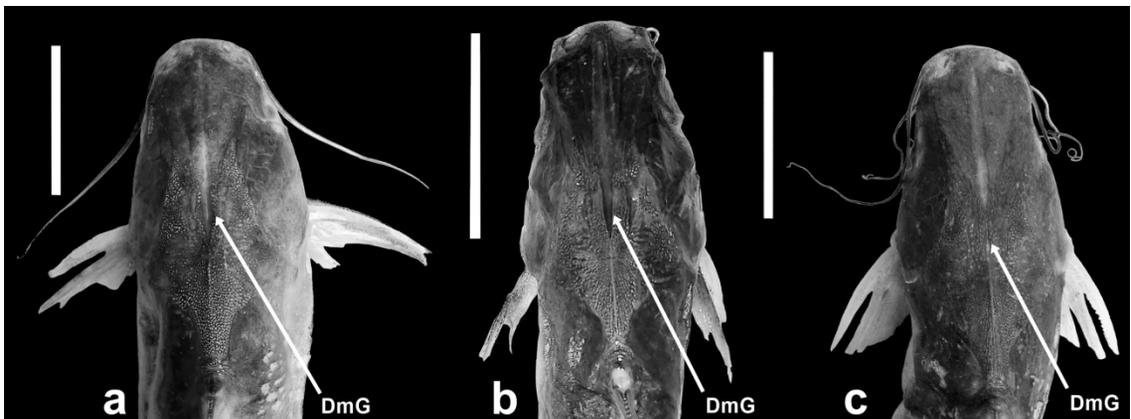


Figure 2. Dorsal view of the head showing the dorsomedial groove between the frontals area in the cephalic shield. (a) *Cathorops spixii*, 204 mm Lt; (b) *Cathorops agassizii*, 158 mm Lt; (c) *Cathorops arenatus*, CPUFMA 11871, 175 mm Lt. Abbreviation: DmG = dorsomedial groove. Scale bars = 30 mm.

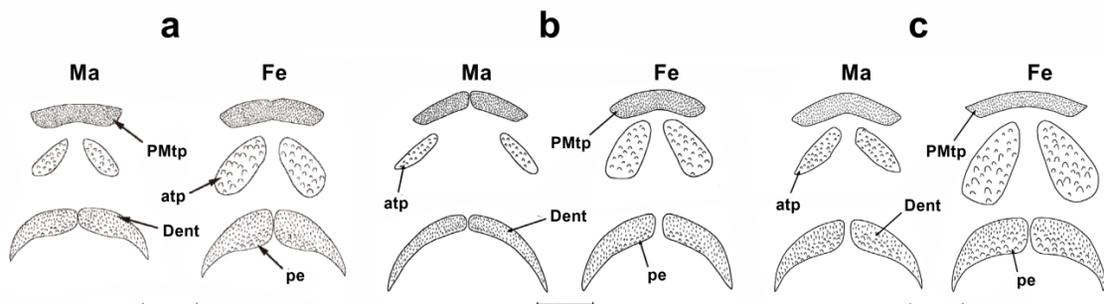


Figure 3. Illustrations of tooth plates of *Cathorops* species. (a) *Cathorops spixii*; (b) *Cathorops agassizii*; (c) *Cathorops arenatus*. Abbreviations: Ma = male; Fe = female, atp = accessory tooth plates; Den = dentary; pe = posterior expansion PMtp = premaxillary tooth plate. Scale bars = 2 mm. Fig. 3a: adapted from Marcenniuk *et al.* (2012, p. 83). Fig. 3b-c: adapted from Marceniuk (2007, p. 367 and 372).

*Notarius bonillai* have been reported erroneously in several studies related to the fish fauna of fresh and estuarine waters in the Ilha do Maranhão, northeastern Brazil, being cited as *Hexanemataichthys bonillai* (e.g., Silva Júnior *et al.* 2007, SEMA 2010, Silva *et al.* 2018), *Arius bonillai* (Castro *et al.* 2010), *Ariopsis bonillai* (Soares *et al.* 2011, Silva Júnior *et al.* 2013) or *Notarius bonillai* (Aguiar-Santos *et al.* 2018). *Notarius bonillai* has also been reported in the state of Sergipe (Araújo *et al.* 2017), and in fishing production data of fish captured in the Brazilian territory (MPA 2009, 2010, 2011). However, we did not analyze samples collected in other Brazilian states.

In study related to the fish fauna of Ilha do Maranhão, organized by the Secretary of State for the Environment and Water Resources (Secretaria de Estado do Meio Ambiente e Recursos Naturais-SEMA) (SEMA 2010), *Notarius bonillai* was reported for estuaries of the rio Anil and rio Paciência. When checking the photographic guide of SEMA (2010), we verified that *Cathorops arenatus* was erroneously reported as *Notarius bonillai* (Fig. 4), with popular name of “uriacica”. In addition, the popular name “uriacica” is used in the north and northeastern of Brazil for species of *Cathorops* Jordan & Gilbert, 1883 (Martin-Juras *et al.* 1987, Freire & Pauly 2005, Silva & Silva 2012).



Figure 4. *Cathorops arenatus*, erroneously reported as *Notarius bonillai*. Figure adapted from SEMA (2010, p. 409).

The correct identification of the species of *Cathorops* becomes relevant due to the great abundance and ecological importance of these species in the coastal, estuarine and freshwater environments where they occur (Etchevers 1978, Mishima & Tanji 1981, Lara-Domínguez *et al.* 1982, Castro 2001, Barletta *et al.* 2003, Lasso *et al.* 2004a,b, Marceniuk 2007, Ayala-Pérez *et al.* 2008, Acero 2011). In the state of Maranhão *Cathorops* species are among the main fishery resources, mainly in coastal communities, being caught during the whole year (Almeida 2009).

As there is no evidence of the presence of *Notarius bonillai* in Brazil (with specimens in collections), and according to taxonomic comparisons performed in this study, we suggest a nomenclature update in fish identified as *Notarius bonillai*, which is an endemic catfish of the two rivers and their estuaries, which flow into the coast of the Caribbean Sea of Colombia. Therefore, fish identified as *Notarius bonillai* in the study area, based on morphological characters, should be cited as *Cathorops arenatus* (Valenciennes, 1840), in the Ilha do Maranhão, Maranhão, Brazil.

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#### STATEMENT ON THE WELFARE OF ANIMALS

All applicable international, national, and/or institutional guidelines for the care and use of animals were followed. All procedures performed in studies involving animals were in accordance with the ethical standards from the Chico Mendes Institute for Biodiversity and Conservation (Instituto Chico Mendes de Conservação da Biodiversidade, ICMBio; license number 64161-1).

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