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Original Article

Gobionellus stomatus Starks 1913 (Oxudercidae: Gobionellinae): range extension for the coastal zone of the Brazilian Amazon region

Gobionellus stomatus Starks 1913 (Oxudercidae: Gobionellinae): extensão de distribuição para a zona costeira da região amazônica brasileira

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Abstract

Gobionellus stomatus, a fish species endemic to Brazil, was previously known to occur from the State of Piauí to the State of Rio Grande do Sul. Here we present the first record of this species for the State of Maranhão, specifically for the Upaon-Açu island, extending its distribution further west, to the coastal zone of the Amazon region. This species inhabits estuarine ecosystems susceptible to environmental pressures, such as pollution and the introduction of non-native species. Despite *G. stomatus* being classified as of least concern for conservation, it is crucial to highlight potential risks associated with human activities in these environments, emphasizing the importance of preservation measures to mitigate future impacts on the populations of this species, as well as of other estuarine gobies.

Keywords: estuarine fish, estuarine pollution, ichthyology, new record, Upaon-Açu island.

Resumo

Gobionellus stomatus, uma espécie de peixe endêmica do Brasil, tinha ocorrência conhecida apenas do estado do Piauí ao estado do Rio Grande do Sul. Apresentamos aqui o primeiro registro desta espécie para o estado do Maranhão, mais especificamente para a ilha Upaon-Açu, estendendo sua distribuição mais a oeste, até a zona costeira da região Amazônica. Esta espécie habita ecossistemas estuarinos suscetíveis a pressões ambientais, tais como poluição e introdução de espécies não nativas. Embora *G. stomatus* seja classificada como de menor preocupação para a conservação, é crucial destacar os riscos potenciais associados às atividades humanas nesses ambientes, ressaltando a importância de medidas de preservação para mitigar impactos futuros nas populações desta espécie, assim como de outros gobídeos estuarinos.

Palavras-chave: peixes estuarinos, poluição estuarina, ictiologia, novo registro, ilha Upaon-Açu.

1. Introduction

The genus *Gobionellus* Girard 1858 belongs to the family Oxudercidae and comprises seven valid species inhabiting estuarine zones and coastal waters: *Gobionellus daguae* (Eigenmann 1918), *Gobionellus hastatus* Girard 1858, *Gobionellus liolepis* (Meek & Hildebrand 1928), *Gobionellus microdon* (Gilbert 1892), *Gobionellus occidentalis* (Boulenger 1909), *Gobionellus oceanicus* (Pallas 1770), and *Gobionellus stomatus* Starks 1913 (Fricke et al., 2024). They usually occur in the subtropical and tropical Atlantic oceans; however, some species also occur in the eastern Pacific. This wide geographic distribution may be a consequence of their small-sized bodies, their benthic and demersal habit, and their wide ecological plasticity, which allow these species to inhabit different marine and estuarine environments, including waters with lower salinity levels (Darcy, 1980; Andrade et al., 2020).

The muckraker *Gobionellus stomatus* is endemic to Brazil (Moura et al., 2003; Pezold, 2004; Froese and Pauly, 2024; Botero et al., 2023; Fricke et al., 2024). Pezold (2004), in a taxonomic revision of the genus, considered it restricted to the area extending from the State of Ceará to the State of Rio de Janeiro. Currently, this species is known from Northeastern, Southeastern, and Southern regions of Brazil, occurring in the following States: Alagoas, Bahia,

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Ceará, Espírito Santo, Paraíba, Paraná, Pernambuco, Piauí, Rio de Janeiro, Rio Grande do Norte, Rio Grande do Sul, Santa Catarina, São Paulo, and Sergipe (Botero et al., 2023; ICMBio, 2024).

Here we provide an updated map of the geographic distribution of the species, based on material deposited in collections, as well as extend the distribution of the species further west, for the coastal zone of the Brazilian Amazon region in the State of Maranhão, more specifically for the Upaon-Açu island.

2. Material and Methods

2.1. Study area, collection, fixation and preservation of the material

The specimens were collected at the Mouth of the Jaguarema River, Araçagy locality, São José de Ribamar municipality, Upaon-Açu island, State of Maranhão, northeastern Brazil (Figure 1), using trawl nets with dimensions of 2 meters in length by 1.8 meters in height, and a mesh width of 2 millimeters. After collection, the specimens were euthanized by submersion in a solution with 0.2 ml/l of eugenol, following prior procedures for Gobionellinae specimens (Chen et al., 2022). The specimens fixation and preservation was conducted by immersion in a 10% formalin solution for a period of ten days and posterior transference to a 70% ethanol solution. The material is deposited in the following collections: Ichthyological Collection of the State University of Maranhão (CIUEMA), São Luís, Maranhão; Ichthyological Collection of the Center for Agricultural and Environmental Sciences (CICCAA), Chapadinha, Maranhão; and Department of Ichthyology of the California Academy of Sciences (CAS), San Francisco, California, U.S.A. Sampling events were carried under the permits issued by Instituto Chico Mendes de Conservação da Biodiversidade (ICMBIO; License nº 79948/2).

2.2. Identification, morphological examination and geographic distribution

Specimens identification was based on anatomic characters proposed by Pezold (2004). Morphological analyses and counts were conducted following Pezold (2004), using a stereomicroscope. Examination of internal anatomy features were conducted on a single cleared and stained (C&S) specimen (CICCAA 07941), prepared according to the protocol proposed by Taylor and Van Dyke (1985), and based on a x-ray image of the holotype (CAS-SU 22219). Total vertebrae counts include the hypural complex, considered as a single element.

To compile species occurrence data, we utilized georeferenced records from the Global Biodiversity Information Facility – GBIF (2023), SpeciesLink (CRIA, 2023), and Instituto Chico Mendes de Conservação da Biodiversidade – ICMBio (2024) databases. To enhance data precision, inaccurate identifications (those labeled as 'aff.', 'cf.', or 'sp.') were not considered. In addition, data provided by GBIF and SpeciesLink were considered only when specimens were preserved in scientific collections and geographic coordinates were available. We excluded doubtful coordinates, which are incoherent and inconsistent with the species' habitat and ICMBio's map of the species. The compiled occurrence data of *Gobionellus stomatus* is provided in Table S1. To visualize the species' occurrence expansion and current distribution, we generated a map using QGIS software version 3.32.3 (QGIS Development Team, 2023).

3. Results

Gobionellus stomatus Starks, 1913. Holotype: CAS-SU 22219, male, 86.2 mm SL, Natal, Brazil.

Specimens examined: Brazil, State of Maranhão: São José de Ribamar municipality: Mouth of the Jaguarema River (estuary), Araçagy. 02°28'25.9"S 044°12'58.7"W, 01/May/2021, E. C. Guimarães, P.S. Brito, C. D. M. Aick & J. P. Santos: CIUEMA 0666, 4, 27.18-31.06 mm SL; CICCAA 07942, 1, 31.03 mm SL; CICCAA 07941, 1 C&S, 32.40 mm SL.

Brazil, State of Rio Grande do Norte: Natal Municipality: Pool near mouth of harbor, 05°48'46"S 035°10'32"W: CAS-SU 22219, x-ray image, holotype, available in Catania (2023).

Species identification: The specimens (Figure 2) were identified as *G. stomatus*, according to the following steps from Pezold (2004) key for species identification:

Figure 1. Collection site of *Gobionellus stomatus*: a) Mouth of the Jaguarema River (estuary), Araçagy, São José de Ribamar municipality, Maranhão, Brazil; and b) specimens being collected using trawl net.

Figure 2. *Gobionellus stomatus*: CICCAA 07942, 1 specimen, 31.03 mm SL.

1a - Scales over trunk region from second dorsal fin and anal-fin origins to caudal fin base cycloid; and 2b - One more element in anal fin than second dorsal fin (usually 14 and 13, respectively); first dorsal fin base extends to second dorsal fin, but not broadly connected; and sides of trunk with vertically elongate midlateral blotches extending above and below midline.

In addition, the specimens examined by us exhibit the following features that fit the species description proposed by Pezold (2004): terminal and oblique mouth; dark spot in the upper half of the base of the pectoral fin, and a broad suborbital spot crossing the cheek from the eye to the middle of the upper jaw; 13-14 elements in the second dorsal fin, 14-15 elements in the anal fin; dorsal fins not broadly connected; body covered with small cycloid scales, 58–65 scales in lateral series; first gill arch with 14 fine gill rakers; and horizontal line from the middle of the cheek 'b' does not extend beyond the 3rd or 4th transverse suborbital line (Figure 2 , Table 1 and Pezold, 2004).

Distribution: Known only from Brazilian coast, encompassing an extensive range of coastal ecosystems (Figure 3 – new record and previous records). In this study, we provide the first record of this species for the coastal region of the Brazilian Amazon in the State of Maranhão, in the Upaon-Açu island (Figure 3 – new record). Therefore, its new distribution is from the State of Maranhão south to the State of Rio Grande do Sul.

Figure 3. Updated map of the distribution of *Gobionellus stomatus*. Circles may represent more than one record, depending on proximity.

4. Discussion

This study reports the first occurrence of *G. stomatus* for the Upaon-Açu island in the State of Maranhão, extending its geographic distribution further west, to the coastal zone of the Brazilian Amazon region (Figure 3). So far, the nearest confirmed record of this species (i.e., with a specimen deposited in a scientific collection) was in the State of Piauí, thus our finding represents a distribution extension of about 300 km in a straight line and about 400 km following the coastline (Figure 3). In the last decade, new records of gobies for Maranhão have been published, which demonstrates that in recent years this group has been more studied in the state (e.g., Guimarães et al., 2017; Brito et al. 2019; Marceniuk et al., 2021; Trevisan et al. 2022).

According to the most recently published list of threatened species from Brazil, *G. stomatus* was categorized as Least Concern (LC) (ICMBio, 2024). However, despite this classification, there are potential risks to its preservation due to the influences arising from human activities in estuarine environments (Queiroz et al., 2018; Gabriel et al., 2021; Sá et al., 2021).

Estuarine ecosystems, the typical habitat of *G. stomatus*, are subject to several human pressures, including pollution resulting from industrial, urban, and agricultural activities, commercial and non-commercial fishing, increased phosphorus in estuarine sediments, as well as sea level rise (Marins et al., 2011; Nerem et al., 2018; Queiroz et al., 2018; Gabriel et al., 2021; Chaves, 2021; Noleto et al., 2022). Another potential threat arises from the introduction of non-native species, a common occurrence in estuaries (e.g Soares et al., 2011; Lasso-Alcalá et al., 2011; Rabelo and

Table 1. Meristic data of *Gobionellus stomatus*.

Meristic data	*Gobionellus stomatus*		
	Material examined from Maranhão	**Pezold (2004)**	**Holotype CAS-SU 22219**
Standard length – SL (mm)	27.18-32.40	27.9–86.5	86.2
First dorsal-fin elements	6	6	6
Second dorsal-fin elements	13-14	13	13
Anal-fin elements	14-15	14	14
Scales in lateral series	58-65	54–66	-
Fine gill rakers in first gill arch	14	14	-
Pectoral-fin rays	19	-	-
Pelvic-fin elements	6	-	-
Total caudal-fin rays	34	-	-
Total vertebrae	26	-	26

Soares, 2014; Bonfim et al., 2017; Cordeiro et al., 2020; Catelani et al., 2021; Trevisan et al. 2022; Franco et al., 2023; Maggioni et al., 2023).

Furthermore, coastal ecosystems face challenges related to climate change (Oliveira-Gomes and Bernardino, 2020; Soares et al., 2021). The combination of these actions is a significant factor in habitat change and decline of food resources for estuarine fish (Ferreira et al., 2016; Lima et al., 2016; Vendel et al., 2017; Ferreira et al., 2018; Trevizani et al., 2019; Andrades et al., 2020; Amorim et al., 2020; Dantas et al., 2020; Justino et al., 2021; Santos et al., 2023), including *G. stomatus*, a species often associated with anthropogenic waste in its diet, highlighting the direct influence of pollution in this feeding interaction (Justino et al., 2021; Santos et al., 2023).

In northeastern Brazil, events such as extreme drought and modifications in water flows, mainly due to the presence of dams, cause impacts on coastal ecosystems (Soares et al., 2021). Therefore, considering the endemic condition of *G. stomatus* to the Brazilian coast (Figure 3), it becomes imperative to adopt preventive measures, even if the species is not currently classified as threatened. Urbanization along the coastal region and pollution of estuarine urban areas are some of the main threats to these ecosystems (Polette & Lins-de-Barros, 2012; Farias, 2014; Santana et al., 2015; Pinho & Carriço, 2021; Rodrigues et al., 2022), which are essential for *G. stomatus* and other gobies.

The extension of the distribution of *Gobionellus stomatus* to the coastal zone of the Brazilian Amazon underscores the pressing need to study coastal areas. Although currently classified as Least Concern, the species faces significant threats in estuarine ecosystems, notably arising from pollution from anthropogenic activities, climate change, introduction of non-native species, and fishing pressure. Furthermore, the direct feeding interaction with anthropogenic waste highlights the vulnerability of *G. stomatus*. Faced with these complex threats, preventive measures and management strategies are imperative to safeguard not only this species conservation, but also the integrity of the coastal ecosystems. This is particularly important considering the role of these environments in maintaining biodiversity and providing ecosystem services.

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Supplementary Material

Supplementary material accompanies this paper.

Table S1. Compiled occurrence data of *Gobionellus stomatus* based on Global Biodiversity Information Facility - GBIF, SpeciesLink, and Instituto Chico Mendes de Conservação da Biodiversidade - ICMBio databases.

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