



## Distribution, morphological notes and conservation status of the psammophilus *Microcambeva* catfishes (Siluriformes: Trichomycteridae)

LUISA M. SARMENTO-SOARES<sup>1,2,7,8</sup>, TIAGO C. PESSALI<sup>3</sup>, VINÍCIUS J. C. REIS<sup>4</sup>,  
LUCAS S. DE MEDEIROS<sup>5</sup>, SERGIO M. Q. LIMA<sup>5</sup>, JULIANA P. SILVA<sup>6</sup>,  
RONALDO F. MARTINS-PINHEIRO<sup>7</sup> & MÁRIO C. C. DE PINNA<sup>4</sup>

<sup>1</sup>Programa de Pós-Graduação em Biologia Animal (PPGBAN), Universidade Federal do Espírito Santo (UFES), 29043–900, Vitória, ES, Brazil. E-mail: sarmento.soares@gmail.com

<sup>2</sup>Universidade Federal do Sul da Bahia, Centro de Formação em Ciências Ambientais (Campus Sosígenes Costa), BR 367, Km 10, Rod. Porto Seguro-Eunápolis, 45810-000, Porto Seguro, BA, Brazil.

<sup>3</sup>Museu de Ciências Naturais da Pontifícia Universidade Católica de Minas Gerais, 30535–901, Belo Horizonte, MG, Brazil. E-mail: tcpeessali@hotmail.com

<sup>4</sup>Museu de Zoologia da Universidade de São Paulo, 04218–970, São Paulo, SP, Brazil. E-mail: carvalhvincicius@gmail.com; pinna@ib.usp.br

<sup>5</sup>Laboratório de Ictiologia Sistemática e Evolutiva, Departamento de Botânica e Zoologia, Universidade Federal do Rio Grande do Norte, 59978–970, Natal, RN, Brazil. E-mail: lucasmedeiros0@hotmail.com; smaialima@gmail.com

<sup>6</sup>Instituto Nacional da Mata Atlântica, Av. José Ruschi, 4, centro Santa Teresa, ES, Brazil. E-mail: 1414juliana@gmail.com;

<sup>7</sup>Instituto Nossosriachos, Estrada de Itacoatiara, 356, casa 4, Itacoatiara, Niterói, RJ, Brazil.

E-mail: 1414juliana@gmail.com; pinheiro.martins@gmail.com

<sup>8</sup>Corresponding author. E-mail: sarmento.soares@gmail.com

### Abstract

Sarcoglanidinae and Glanapteryginae catfishes are among the most unusual elements of the Neotropical freshwater fish fauna. *Microcambeva ribeirae*, *M. barbata* and *M. draco* are miniaturized Sarcoglanidinae known to occur in sandy microhabitats in drainages of the Brazilian Atlantic Forest. Due to their specific habitats, specimens of *Microcambeva* are rare in fish collections, and new records are considered noteworthy to warrant report. Recently, specimens of this genus were newly found in the Rio Doce basin in Minas Gerais and Espírito Santo States. Such new records expand the known geographic distribution of *Microcambeva*. Further records of *Microcambeva* for Rio Peruípe in south Bahia State are also reported. Comments on the distribution of *Microcambeva* species along the Atlantic Forest coastal basins and suggestions on its conservation status are also offered.

**Key words:** Atlantic Forest, biodiversity, conservation, Trichomycteridae, Sarcoglanidinae

### Resumo

Os bagres Sarcoglanidinae e Glanapteryginae estão entre os elementos mais incomuns da ictiofauna Neotropical de água doce. *Microcambeva ribeirae*, *M. barbata* and *M. draco* são Sarcoglanidinae miniaturizados conhecidas por habitar micro-habitats arenosos em drenagens da Mata Atlântica do Brasil. Devido aos seus habitats específicos, espécimes desse gênero são raros em coleções, e novos registros são considerados dignos de nota. Recentemente, esse gênero foi reportado em uma nova drenagem, a bacia do rio Doce nos estados de Minas Gerais e Espírito Santo. Este novo registro expande a distribuição geográfica conhecida de *Microcambeva*. Outros registros de *Microcambeva* para o rio Peruípe no sul da Bahia também foram reportados. Comentários sobre a distribuição das espécies de *Microcambeva* ao longo das bacias costeiras da Mata Atlântica e sugestão sobre seu estado de conservação também são fornecidos neste trabalho.

**Palavras chave:** Mata Atlântica, biodiversidade, conservação, Trichomycteridae, Sarcoglanidinae

## Introduction

Trichomycteridae catfishes are among the most interesting members of the order Siluriformes in the freshwater rivers of the Neotropics. Its members are arranged in eight subfamilies that include more than 300 valid species (Eschmeyer *et al.* 2019), distributed in different habitats and possessing diverse feeding behaviors (from insectivorous to hematophagous). The subfamily Sarcoglanidinae, originally erected by Myers & Weitzman (1966), was previously known by small-sized trichomycterids, with little dark pigmentation, living in association with sandy riverine habits (psammophilous habits) (Zuanon *et al.* 2006). Currently, this subfamily comprises 11 known species distributed in six genera, with three of them monotypic: *Malacoglanis gelatinosus* Myers & Weitzman, *Sarcoglanis simplex* Myers & Weitzman and *Stauroglanis gouldingi* de Pinna (Myers & Weitzman 1966; de Pinna 1989; de Pinna & Starnes 1989). The remaining genera contain the following species: *Ammoglanis* Costa (*A. diaphanus* Costa; *A. pulex* de Pinna & Winemiller; and *A. amapaensis* Mattos, Costa & Gama), *Microcambeva* Costa & Bockmann (*M. barbata* Costa & Bockmann; *M. ribeirae* Costa, Lima & Bizerril; and *M. draco* Mattos & Lima), and *Stenolicmus* de Pinna & Starnes (*S. sarmientoi* de Pinna & Starnes; and *S. ix* Wosiacki, Coutinho & de Assis Montag) (de Pinna & Starnes 1990; Mattos & Lima 2010; Wosiacki *et al.* 2011).

*Microcambeva* is distinguished from all other Sarcoglanidinae by having a rectangular lower hypural plate, a reduced dorsal process of the quadrate and 9–13 opercular odontodes (Costa & Bockmann 1994). *Microcambeva* species occur in the Atlantic Forest drainages, while all other species of the subfamily occur in Amazonian rivers. The three species described in *Microcambeva* are all inhabitants of coastal rivers between north of Paraná to south Bahia States. The type species of the genus, *Microcambeva barbata*, was first reported in the Rio São João basin, a coastal drainage of Rio de Janeiro State (Costa & Bockmann 1994) in the Fluminense Ecoregion 352 *sensu* Abell *et al.* (2008). *Microcambeva ribeirae* was described from the Rio Ribeira de Iguape basin, São Paulo State (Costa *et al.* 2004), Ecoregion 330 *sensu* Abell *et al.* (2008). *Microcambeva draco* is known from two specimens from the Rio Jucuruçu, coastal drainage in extreme southern Bahia State (Mattos & Lima 2010), Ecoregion 328 *sensu* Abell *et al.* (2008).

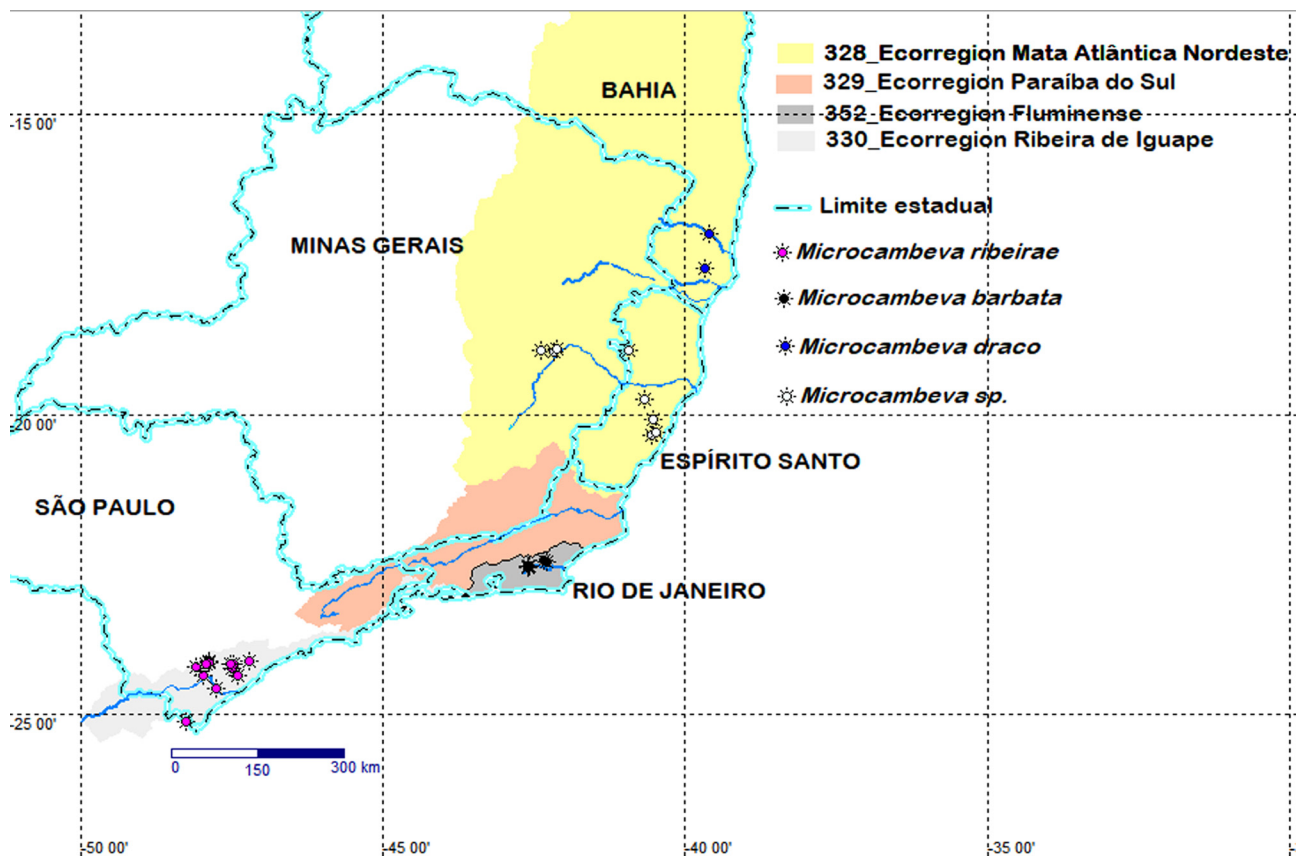
All these three species currently included in *Microcambeva* are rare in museum collections. This is in part due to their highly specialized habitats, which sometimes requires specific sampling techniques, such as the use of fine sieves (5 mm mesh), in moderate to slow current shallow waters, with sand or fine gravel bottom substrate, in the twilight or at night.

After the first geographically disjointed report of a sarcoglanidine by Costa & Bockmann (1994), to Rio de Janeiro State in the Atlantic Forest biome, Costa *et al.* (2004), described a second species of the genus, *M. ribeirae*, reporting two possibly new species in the Rio Doce basin and another in the Rio Jucuruçu basin, southern Bahia, attesting that the geographical distribution of the genus would be even larger in this biome. Backup *et al.* (2007) reported the existence of additional populations from a tributary of the Rio São José, lower Rio Doce basin at Espírito Santo State (MZUSP 53223) and another in the Rio Santo Antônio, a tributary of Rio Doce at Minas Gerais State (ANSP 174051). Later, Mattos & Lima (2010) based on specimens reported from the Rio Jucuruçu, described *M. draco* from the northernmost geographical distribution of the genus.

Still, diversity of *Microcambeva* is underestimated and new species await description. The coastal drainages at Espírito Santo State, south of the Rio Doce basin, in the Rio Santa Maria da Vitória and in the middle Rio Doce basin in Minas Gerais State, in one of its tributaries Rio Corrente Grande, are localities where possible new species were found and await detailed analyses for species hypotheses confirmation. The present contribution aims to give additional information to understand the distribution of *Microcambeva* species.

## Material and methods

Abell *et al.* (2008) divided South America into 49 continental aquatic ecoregions, attributing to each one a corresponding number, ordered globally. *Microcambeva* species are recorded for ecoregions along Brazilian States of Bahia, Espírito Santo, Minas Gerais, Rio de Janeiro, São Paulo and Paraná. From north to south, these fishes are known to occur at the following ecoregions: Northeastern Mata Atlântica (328); Fluminense (352); Ribeira de Iguape (330). Based on the collection records and fieldwork a georeferenced map was elaborated using the GPS Trackmaker Professional 4.8 program (Ferreira Júnior 2012) based on charts from IBGE de 1:100.000 and field verifications (Fig. 1).



**FIGURE 1.** Map of section of Brazil indicating collection records of *Microcambeva*, along states of Bahia; Minas Gerais; Espírito Santo; Rio de Janeiro; São Paulo and Paraná, with indication of respective ecoregions in the area (Northeastern Mata Atlântica (328); Paraíba do Sul (329); Fluminense (352); Ribeira de Iguape (330). Main rivers with record of *Microcambeva* specimens indicated in map. From north to south: Rio Jucuruçu, Rio Peruípe, Rio Mucuri, Rio Doce, Rio Paraíba do Sul, Rio São João and Rio Ribeira de Iguape. Respective type localities indicated in smaller maps in Figs. 3, 5 and 8.

In order to investigate the presence of additional populations of *Microcambeva* in the Rio Doce basin, field expeditions were held. Each collecting site was photographed and georeferenced with a GPS receiver (Global Positioning System). Specimens were caught using a sieve (5 mm mesh) along the riverbank with moderate to slow current in shallow waters. Specimens were anesthetized using diluted eugenol solution (Lucena *et al.* 2013) and subsequently fixed in 10% formalin and latter transferred to 70% alcohol. A few specimens were fixed directly in absolute alcohol for genomic analysis. Some specimens were photographed alive and all specimens collected were deposited in fish collections. Museum catalog numbers are in the Examined Material section.

Institution abbreviations: Museu Nacional, Universidade Federal do Rio de Janeiro (MNRJ); Museu de Zoologia da Universidade Estadual de Londrina (MZUEL); Museu de Zoologia da Universidade de São Paulo (MZUSP); Museu de Ciências e Tecnologia da Pontifícia Universidade Católica do Rio Grande do Sul (MCP); Universidade Estadual Paulista, São José do Rio Preto (DZSJRPP); and Universidade Federal do Rio Grande do Sul (UFRGS). Voucher numbers at Examined Material.

Taxonomic identification of collection material of *Microcambeva* was based on the original descriptions of *M. barbata* (Costa & Bockmann 1994), *M. ribeirae* (Costa *et al.* 2004), and *M. draco* (Mattos & Lima 2010). An intermediate form recognized in the present study is listed (as *Microcambeva* sp.). Complementary anatomical features were provided by cleared and stained specimens following Taylor & Van Dyke (1985). Cleared and stained specimens are identified as (CS) in examined material.

**TABLE 1.** Anatomical characters of *Microcambeva* (Costa & Bockmann 1994; Mattos & Lima 2010). \*Counts follow Costa 1992.

Character	<i>Microcambeva barbata</i>	<i>Microcambeva draco</i>	<i>Microcambeva ribeirae</i>	<i>Microcambeva sp.</i>
extent of nasal barbel	between posterior nostril and eye	posterior nostril	posterior nostril	posterior nostril
extent of maxillary barbel	posterior margin of opercular patch of odontodes	anterior margin of opercular patch of odontodes	between eye and opercular patch of odontodes	anterior margin of opercular patch of odontodes
range of rictal barbel	posterior margin of interopercular patch of odontodes	anterior margin of interopercular patch of odontodes	tip reaching middle of eye	anterior margin of opercular patch of odontodes
position of posterior nostril	closer to anterior nostril than to eye	closer to anterior nostril than to eye	closer to anterior nostril than to eye	closer to eye
opercular odontodes	9–13	11–12	9–14	9–11
interopercular odontodes	6–7	6–7	6–8	6–7
pair of posteriormost supraorbital pores	separated	separated	fused	separated
supraorbital bone size relative to lacrimal	approximately same size as lacrimal	two times the length of the lacrimal	two times the length of the lacrimal	two times the length of the lacrimal
lateral process of sphenotic	short	short	long	short
origin of anal fin	at vertical through vertebra 21	at vertical through vertebra 21	at vertical through vertebra 20	at vertical through vertebra 21
anterior palatine ossification	present	present	absent	present
posterior process of palatine	long	long	short	long
number of dorsal-fin rays	ii, 7	ii-iii, 7	ii, 6	ii, 7
number of pectoral-fin rays	ii, 5, first ray long, filamentous	ii, 6, first ray long, filamentous	ii-iii, 6, first ray shorter than subsequent rays	ii, 6, first ray long, filamentous
number of pelvic-fin rays	i, 4	i, 3-4	i, 4	i, 3, i
number of anal-fin rays	ii, 5	ii, 4-5	ii, 5	ii, 5
number of caudal-fin rays	ii, 11	ii, 11	ii, 10-11	ii, 11

## Results

The genus *Microcambeva* is distinguished from remaining Sarcoglanidinae due to the ventral hypural plate in rectangular form, the dorsal process of the quadrate bone reduced and the reduction in the number of opercular odontodes (9–13) (Costa & Bockmann 1994). The following three different *Microcambeva* species are recognized here, plus one possibly new species from the Rio Doce basin. Morphological and meristic characteristics used to distinguish them from each other are presented in Table 1. The species and morphotypes are presented below following its geographic distribution, from north to south.

### *Microcambeva draco* Mattos & Lima 2010

(Fig. 2)

**Conservation status.** Endangered—EN (MMA 2018; Datovo *et al.* 2019).

**Taxonomic notes.** *Microcambeva draco* is reported as having a short nasal barbel, reaching the anterior margin of the second nostril, while *M. barbata* has a long nasal barbel reaching the posterior margin of the eyes (vs. reaching anterior eye rim in *Microcambeva* sp.); 10 total dorsal-fin rays (iii, 6, i) in *M. draco* original description (vs. 9; ii, 7 in *Microcambeva* sp. and *M. barbata*); opercular odontodes 11–12, interopercular odontodes 6–7 in *M. draco* and 9–13, 6–7 in *M. barbata* (vs. opercular 7–9, interopercular 7–8 in *Microcambeva* sp.). Such differences may be simply continuous variations within a single broadly distributed species, but alternatively may imply that the *Microcambeva* populations in the Rio Doce basin are a distinct species. Considering the knowledge of *M. draco* just from its type locality at Rio Jucuruçu, and few specimens from neighboring river drainages, resolution of this issue requires a more detailed investigation, as stated below.

**Pigmentation pattern.** Overall coloration translucent, with groups of dark brown chromatophores over top of head and sides of trunk. On trunk, chromatophores organized in three narrow rows. Fins hyaline, with few dark chromatophores near their bases, with pelvics completely hyaline. Caudal fin with a narrow dark bar near its base. Faint bar on caudal fin, next to fin base.

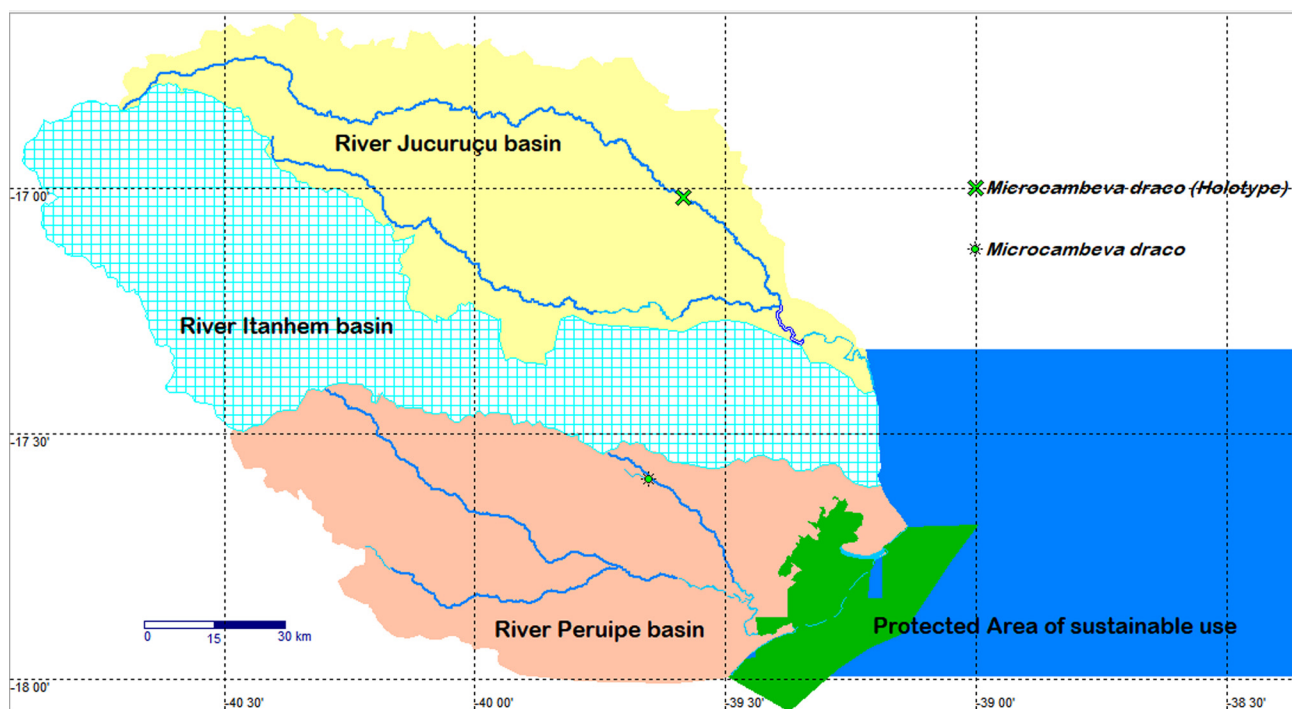
**Distribution.** Lower sections of Atlantic Forest drainages at coastal tablelands, extreme southern Bahia. Ecoregion Northeastern Mata Atlântica (328). There are no records of *M. draco* in conservation units. The species occurrence is extended by further records from extreme southern Bahia, south of its type locality in the Rio Jucuruçu, with records in the Rio Peruípe (Fig. 3).

**Ecological Notes.** The riparian vegetation in the Rio Jucuruçu valley was largely deforested in the upper and middle valleys, where *Microcambeva draco* was found (Sarmiento-Soares *et al.* 2009). The type locality, near Itamaraju, corresponds to an area of sparse areas of secondary forest mostly occupied by pastures and farms, with cattle or agriculture. Siltation is one of the impacting factors for *M. draco* populations (MMA 2018).

**Examined Material.** **Rio Jucuruçu:** MCP 17796, 1, holotype, 24.6 mm SL; Rio Jucuruçu, on farm upstream from Itamaraju, Bahia, Brazil; 17°01'10.0"S 39°34'57.0"W. **Rio Peruípe:** MCP 36634, 11, 17.2–20.3 mm SL; stream tributary of Rio da Fazenda, Rio Peruípe basin, Caravelas, Bahia, Brazil; 17°35'47.00"S 39°38'59.00"W.



**FIGURE 2.** *Microcambeva draco*, preserved specimen. MCP 36634, 20.3 mm SL, stream tributary of Rio da Fazenda, Rio Peruípe basin, Caravelas, Bahia. Lateral view.



**FIGURE 3.** Map of extreme southern Bahia, with indication of records of *Microcambeva draco*. Protected area of sustainable use in dark green. Dotted line indicate continental limits of land, as Extractivist reserve of Cassurubá includes both marine and terrestrial areas. Type locality indicated by an “X”. Additional sampling localities as dots.

***Microcambeva* sp.**

(Fig. 4)

**Conservation status.** Not evaluated.

**Taxonomic notes.** Based on osteological characters, the *Microcambeva* sp. specimens collected in the Rio Doce basin seems to be closely related to *Microcambeva draco*, due to the presence of characters typical of this species (Mattos & Lima 2010; see Table 1). Although meristic and morphometric characters in Table 2 also revealed differences in both populations. The phenotypic variation in comparison to the original description of *M. draco* (Mattos & Lima 2010) need additional investigation, considering the few specimens available from the Rio Jucuruçu and Rio Peruípe respectively. Reduced body pigmentation, large eye and sharp caudal peduncle in comparison to its congeners are remarkable features in favor to recognizing it as a separate species. The contrasting differences pointed out in Table 2 may represent intraespecific variation masked by the few specimens available from the type locality. Some of those distinctions actually correspond to conditions in its closer geographical relative, *M. barbata*. Morphological features do not fit clearly into either of the known species. Thus, the species is in need of investigation to determine its identity.

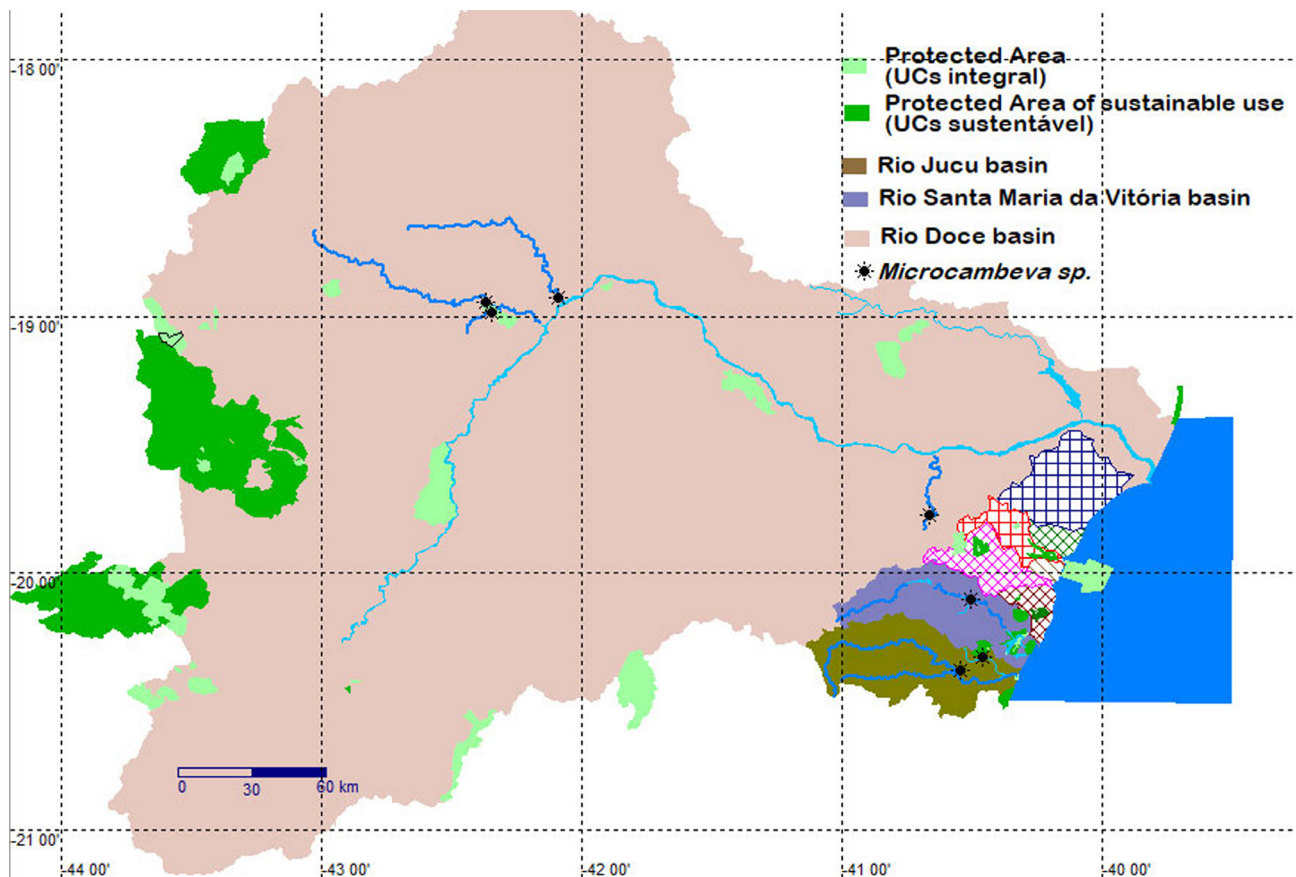
**TABLE 2.** Meristic characters of specimens of *Microcambeva* sp. collected in the Rio Doce river basin contrasted to values from the original description of *Microcambeva draco* (Mattos and Lima 2010). \*Counts follow Costa 1992.

Character	<i>Microcambeva</i> sp. Rio Doce	<i>Microcambeva draco</i> Rio Jucuruçu (Type locality)
Extent of the nasal barbel	Medial portion between the nostril and eye	Posterior nostril
Length of pectoral filament	10% of length of Pectoral-fin	50 % of length of Pectoral-fin
Opercular odontodes	9–10	11–12
Interopercular odontodes	9–10	6–7
Procurent caudal-fin rays	12 or 13 (vi+vi or vi+vii)	11 (vii + vi)

**Pigmentation pattern.** Overall coloration translucent, with scattered dark brown chromatophores over head and latero-dorsal parts of trunk. Dorsal and caudal fins with few dark chromatophores near its base, remaining fins hyaline. Caudal fin with an irregular blotch near fin base.



**FIGURE 4.** *Microcambeva* sp., photographed live. MZUSP 123363, 27.5 mm SL, Ribeirão Porto Santa Rita, Rio Doce basin, Açucena, Minas Gerais. Lateral view.



**FIGURE 5.** Map of the Rio Doce and coastal drainages on central Espírito Santo State, with indication of records of *Microcambeva* sp. Sampling localities as dots.

**Distribution.** Atlantic Forest drainages on central Espírito Santo and eastern Minas Gerais States, in the Rio Doce drainage. Ecoregion Northeastern Mata Atlântica (328) (Fig. 5).

**Ecological notes.** The environment in which *Microcambeva* sp. specimens were found in the Rio Santa Maria, tributary of the lower Rio Doce basin, is a sand beach, with clear water, in a stretch that is 30–60 cm in depth and 3–5 m in width. The substrate was mostly sandy with the presence of very fine gravel. In the Rio Doce tributaries this species lives buried in sandy to fine gravel substrate. No specimens were found in larger gravel or silt. The specimens were found during excavation, in shallow sand-bottom habitats in daylight. Along the stream margin there was moderate riparian vegetation with grasses. Specimens of *Microcambeva* sp., were collected in clear waters in the Rio Corrente Grande, a tributary of the Rio Doce basin, in Minas Gerais State. The stream where the specimens were caught were largely deforested and silted. The stream sections sampled (1.5 to 35.0 m width) have sandy substrate, moderate current, and little marginal vegetation (Fig. 6).

**Examined Material. Rio Doce:** MBML 4383, 1, 29.7 mm SL; Brazil, State of Espírito Santo, Santa Teresa, Rio Santa Maria do Rio Doce on unpaved road between São João de Petrópolis and Vila 25 de Julho between first and second bridges; 19°46'59.80"S 40°39'10.10"W. MBML 4400, 6 (2 CS), 19.6–25.7 mm SL; Rio Santa Maria do Rio Doce on path between Instituto Federal do Espírito Santo, Santa Teresa, Espírito Santo, Brazil. MZUSP 53223, 1, Urucum stream, tributary of Rio São José, Pancas, Espírito Santo, Brazil. MZUSP 123363, 2, 27.2–27.5 mm SL; Ribeirão Porto Santa Rita, tributary of Rio Corrente Grande, Açucena, Minas Gerais, Brazil; 18°57'9.86"S 42°21'38.20"W. MZUSP 123364, 11, 19.5–22.7 mm SL. MZUSP 123365, 16, 20.0–25.9 mm, Ribeirão São Mateus, tributary of Rio Corrente Grande, Açucena, Minas Gerais, Brazil. MZUSP 123346, 2, 24.0–24.2 mm SL; Brazil, State of Minas Gerais, Açucena, Rio Corrente Grande, tributary of Rio Doce basin; 18°57'9.86"S 42°21'38.20"W.



**FIGURE 6.** Collecting localities of *Microcambeva* sp. in the Rio Doce basin. A. Ribeirão Porto Santa Rita, Rio Corrente Grande sub-basin, Açucena, Minas Gerais. B. Ribeirão São Mateus, Rio Corrente Grande sub-basin, Açucena, Minas Gerais. C. Rio Suaçuí Pequeno, Governador Valadares, Minas Gerais. D. Rio Santa Maria do Rio Doce, Santa Teresa, Espírito Santo.

### *Microcambeva barbata* Costa & Bockmann 1994

(Fig. 7)

**Conservation status.** Near Threatened—NT (MMA 2018).

**Taxonomic notes.** *Microcambeva barbata* is distinguished from its congeners based on osteological patterns, such as having the posterior process of the palate very short, the supraorbital bone approximately the same size as the lacrimal, reduced vomer, anterior elongated frontal bone. The first pectoral ray varies in length among the three species of the genus. *Microcambeva barbata* filament is between 20% and 40% larger than the other pectoral rays. In *M. draco*, the filament is much larger, 50%, while in *M. ribeirae* this filament is absent.

**Pigmentation pattern.** Body translucent with faint rows of spots. Scattered dark brown chromatophores latero-dorsal parts of trunk. Caudal fin with a small dark spot near its base, remaining fins hyaline.

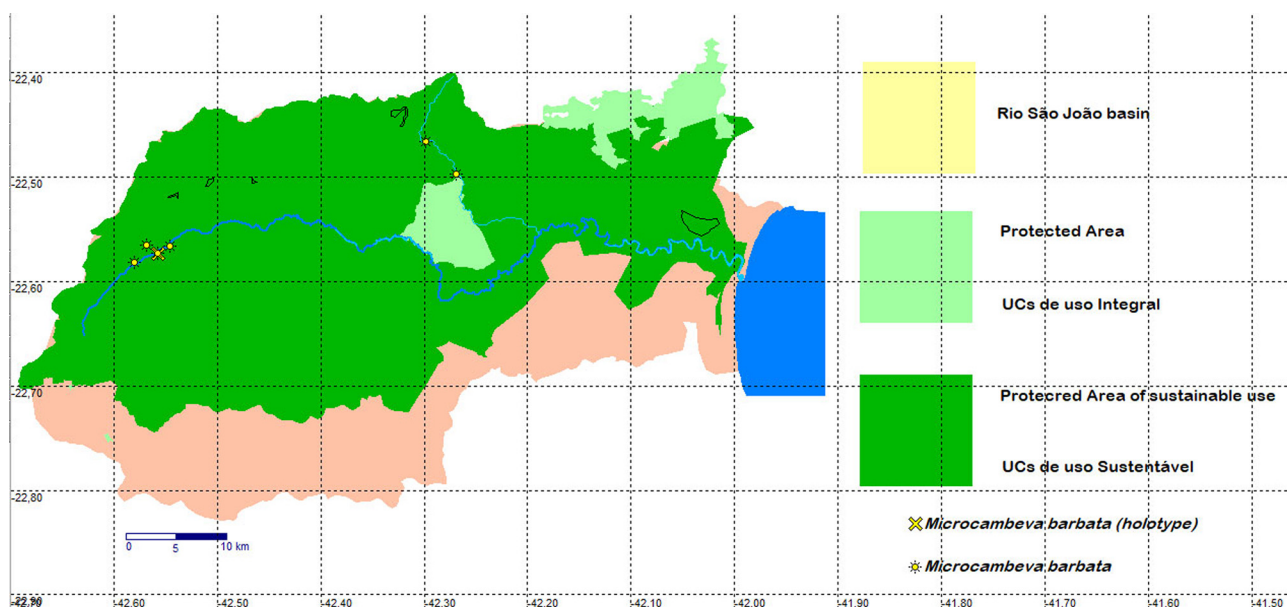
**Distribution.** *Microcambeva barbata* can be found in the Rio São João basin, a coastal drainage in the lake region, on central Rio de Janeiro State. Ecoregion Fluminense (352) (Fig. 8).



**Ecological notes.** Individuals were observed buried in gravel and sand, associated with a substrate of middle grain in granulometry, in shallow waters (C. Moreira, *pers. comm.*). Well-developed opercular and interopercular odontodes, which are externally prominent on head, are possibly morphological advantages for these fishes to anchor themselves in substrate. The species is associated with clear water bodies in shadow environments surrounded by riparian vegetation. Deforestation and in consequence siltation of the Rio São João are main threats to populations (Bockmann & Lima 2008).



**FIGURE 7.** *Microcambeva barbata*, preserved specimen. MZUSP 80225, 21.9 mm SL. Stream tributary of the Rio São João, Silva Jardim, Rio de Janeiro. Lateral view.



**FIGURE 8.** Map of the Rio São João, at lake region on central Rio de Janeiro State, with indication of records of *Microcambeva barbata*. Protected areas of sustainable use in light green, areas of integral protection in dark green. Type locality indicated by an “X”. Additional sampling localities as dots.

**Examined Material. Rio São João:** MZUSP 43678, 1, 24.7 mm SL; Rio São João, near Gaviões, Silva Jardim, Rio de Janeiro, Brazil; 22°34'28.30”S 42°33'22.70”W (estimated coordinates), Holotype. MZUSP 43679, 1, 18.7 mm SL; Rio São João, near Gaviões, Silva Jardim, Rio de Janeiro, Brazil; 22°34'28.30”S 42°33'22.70”W (estimated coordinates), Paratype. MZUSP 79828, 2, 26.4–24.6 mm SL; Rio São João specimens from aquarium, Rio de Janeiro, Brazil; without geographical coordinates. MZUSP 80225, 21, 17.9–24.7 mm SL; stream tributary of the Rio São João, 30 km north on the road Boqueirão-Japuiba, Silva Jardim, Rio de Janeiro, Brazil; 22°34'0.00”S 42°34'0.00”W. MZUSP 80231, 1, 25.3 mm SL; tributary of Rio São João, 28 km north on road Boqueirão-Japuiba, Silva Jardim, Rio de Janeiro, Brazil; 22°34'0.00”S 42°34'0.00”W. MNRJ 37572, 1, 26.3 mm SL; Córrego Aldeia Velha, on bridge to Aldeia Velha road, near Reserva Particular do Patrimônio Natural Fazenda do Bom Retiro, Casimiro de Abreu, Rio de Janeiro, Brazil; 22°28'3.00”S 42°17'51.00”W. MNRJ 47108, 1, 19.6 mm SL;

Rio Aldeia Velha, on BR-101 bridge under construction, Casimiro de Abreu, Rio de Janeiro, Brazil; 22°29'53.00"S 42°16'3.00"W. MNRJ 49371, 1, 22.7 mm SL; Rio Aldeia Velha, at cross section by strip, Casimiro de Abreu, Rio de Janeiro, Brazil; 22°29'54.80"S 42°16'2.40"W. DZSJRP 13861, 1, 25.1 mm SL; tributary of Rio São João, near road RJ 126, Silva Jardim, Rio de Janeiro, Brazil; 22°34'60.00"S 42°34'44.00"W.

***Microcambeva ribeirae* Costa, Lima & Bizerril 2004**

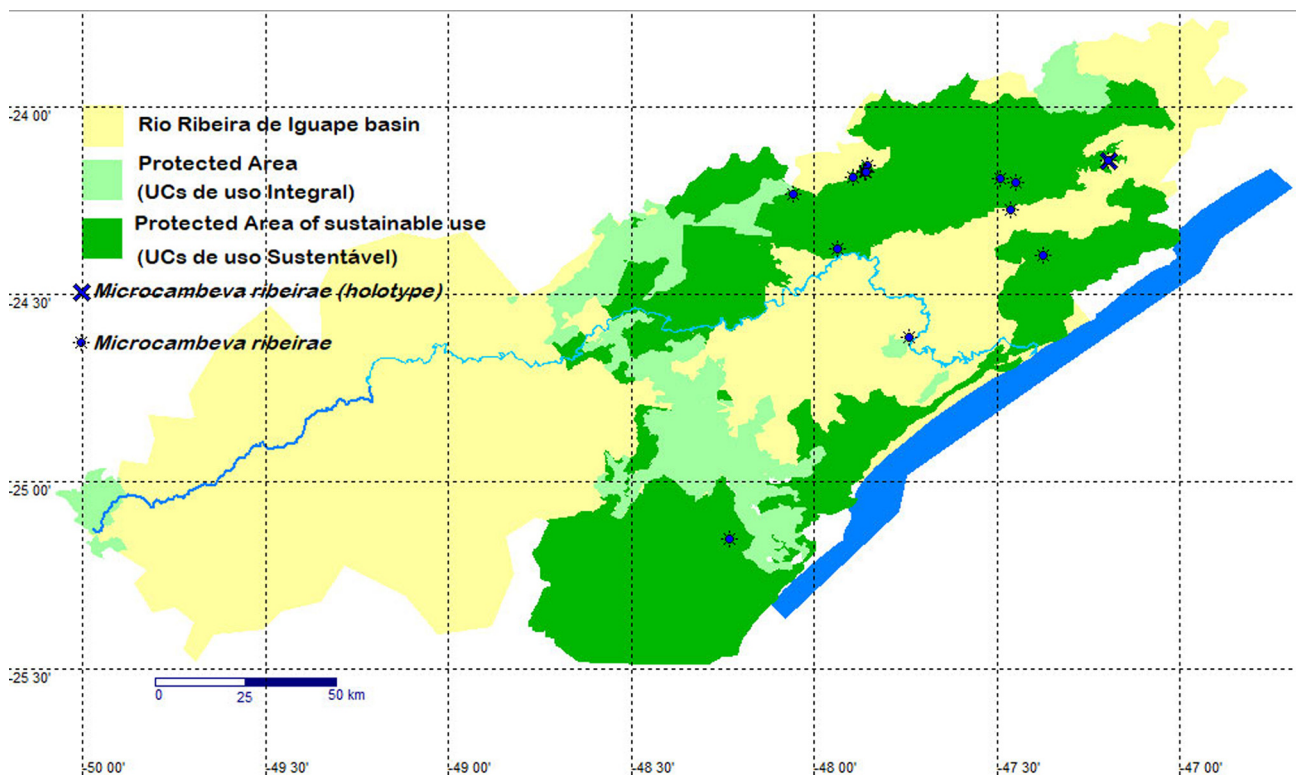
(Fig. 9)

**Conservation status.** Near Threatened—NT (Oyakawa *et al.* 2009; MMA 2018).

**Distribution.** Atlantic Forest drainages in the Northern Paraná State in the Rio Guaraqueçaba basin to southern São Paulo State in the Rio Ribeira de Iguape. Ecoregion Ribeira de Iguape (330) (Fig. 10).



**FIGURE 9.** *Microcambeva ribeirae*, preserved specimen. MZUSP 81624, 40.6 mm SL, Rio Ipiranga, in Fazenda Brasban, Sete Barras, São Paulo. Lateral view.



**FIGURE 10.** Map of the Rio Ribeira de Iguape, southern São Paulo, with indication of records of *Microcambeva ribeirae*. Protected areas of sustainable use in light green, areas of integral protection in dark green. Type locality indicated by an “X”. Additional sampling localities as dots.

**Pigmentation pattern.** Body almost translucent with two rows of dark spots. One dorsolateral row between head and dorsal fin base and a second row almost over lateral line. Dark chromatophores scattered over head. Dark brown spots over top of head, opercular patch of odontodes and caudal fin base.

**Taxonomic notes.** *Microcambeva ribeirae* is easily diagnosed by three very striking characteristics: anterior palatine ossification absent, nine dorsal-fin rays, origin of anal fin at vertical through 20th vertebrae (Costa *et al.* 2004; Table 1). First, this species is the largest among the Sarcoglanidinae, mean of 42.2 mm of standard length, which is one of the most distinctive characters. Second, *M. ribeirae* has a distinct color pattern, with dark spots distributed longitudinally along the body (Fig. 9), ranging from 9–13 spots, depending on length. Third, the first ray of the pectoral-fin of *M. ribeirae* is smaller than subsequent rays. Another relevant external character is the third supraorbital created by the junction of the two supraorbital canals in the suture between the anterior and posterior cranial fontanelles forming a commissure ending in a median pore, S6. The osteological characters of *M. ribeirae* are well delimited, such as the non-elongated frontal bone, anterior portion of the sphenotic with non-prominent lateral process and presence of ossification in the anterior portion of the palate.

**Examined material: Rio Ribeira de Iguape:** MZUSP 84301, 1, 47.8 mm SL; Rio São Lourençinho, on vicinity of São Lourenço, Pedro Toledo, State of São Paulo, Brazil; 24° 8'57.00"S 47°11'27.00"W; MZUSP 78617, 3, 40.3–47.7 mm SL; Rio São Lourençinho, on vicinity of São Lourenço, Pedro Toledo, State of São Paulo, Brazil; 24° 8'57.00"S 47°11'27.00"W; Paratypes. MZUSP 74699, 10, 32.3–47.9 mm SL; Rio Faú, Miracatu, State of São Paulo, Brazil; 24°12'28.00"S 47°26'38.00"W; Paratypes. MZUSP 79953, 7, 25.9–35.6 mm SL; Rio Espirado, Estação Ecológica Juréia-Itatins, Iguape, São Paulo, Brazil; 24°24'11.00"S 47°22'15.00"W; Paratypes. MNRJ 14304, 3, 29.5–32.4 mm SL; Ribeirão Areado, tributary of Rio São Lourençinho, Furadinho village, Miracatu, São Paulo, Brazil; 24°16'51.70"S 47°27'34.40"W; Paratypes. MZUSP 50588, 2, 34.2–37.2 mm SL; Ribeirão da Serra, Porto de Areia, Parque Estadual Carlos Botelho, Sete Barras, São Paulo, Brazil; 24°22'60.00"S 47°55'60.00"W. MZUSP 65765, 3, 39.7–41.1 mm SL; Rio Ipiranga, in Fazenda Brasban, Sete Barras, São Paulo, Brazil; 24°10'47.00"S 47°51'27.00"W. MZUSP 65766, 1, 36.4 mm SL; stream Saibadela in Rio Quilombo at limits of Parque Estadual Carlos Botelho, Sete Barras, São Paulo, Brazil; 24°14'14.00"S 48° 3'9.00"W. MZUSP 65766, 1, 36.4 mm SL; stream Saibadela on confluence with Rio Quilombo at limits of Parque Estadual Carlos Botelho, Sete Barras, São Paulo, Brazil; 24°14'14.00"S 48° 3'9.00"W. MZUSP 68168, 3, 20.3–41.3 mm SL; Sete Barras, Rio Ipiranga, in Fazenda Brasban, Sete Barras, São Paulo, Brazil; 24° 9'41.00"S 47°51'0.00"W. MZUSP 68170, 2, 38.7–40.8 mm SL; Rio Ipiranga, in Fazenda Brasban, Sete Barras, São Paulo, Brazil; 24°10'37.00"S 47°51'24.00"W. MZUSP 69405, 4, 36.2–43.8 mm SL; Rio Faú, on bridge to Faú village, Miracatu, São Paulo, Brazil; 24°11'46.00"S 47°29'17.00"W. MZUSP 69425, 12, 35.1–41.9 mm SL; Rio Ipiranga, in Fazenda Brasban, Sete Barras, São Paulo, Brazil; 24° 9'41.00"S 47°51'0.00"W. MZUSP 81624, 26, 24.2–41.2 mm SL; Sete Barras, Rio Ipiranga, in Fazenda Brasban, Sete Barras, São Paulo, Brazil; 24°10'47.00"S 47°51'27.00"W. MZUSP 84367, 3, 21.2–41.1 mm SL; Rio Preto, near Rio Preto village, Sete Barras, São Paulo, Brazil; 24°11'33.00"S 47°53'25.00"W. MZUSP 84381, 8, 37.4–43.1 mm SL; Rio Ipiranga, in Fazenda Brasban, Sete Barras, São Paulo, Brazil; 24°10'46.00"S 47°51'14.00"W. MZUSP 116104, 35, 25.7–37.1 mm SL; Rio Espirado, in Estação Ecológica Juréia-Itatins, Iguape, São Paulo, Brazil; 24°24'11.00"S 47°22'15.00"W. MZUSP 116750, 5, 35.7–37.4 mm SL, Rio Preto, near Rio Preto village, near border of Parque Estadual Carlos Botelho, Sete Barras, São Paulo, Brazil; 24°11'33.00"S 47°53'25.00"W. MNRJ 37165, 1, 35.1 mm SL; Rio Jacupiranga, Jacupiranga, São Paulo, Brazil; 24°37'17.30"S 47°44'6.20"W (estimated coordinates). **Rio Guaraqueçaba:** UFRGS24759, 1, 37.3 mm SL; stream near road PR-405, tributary of Rio Guaraqueçaba, Guaraqueçaba, Paraná, Brazil; 25° 9'28.40"S 48°13'42.80"W.

## Discussion

Among the eleven species placed in Sarcoglanidinae, *Microcambeva* species are the only ones to occur in the Atlantic Forest domain (Costa & Bockmann 1994). As these fishes appear to have a low mobility, the species are expected to have restricted geographic distributions. However, their distribution pattern seems to be larger than currently known (Zuanon *et al.* 2006). Despite their small size, *Microcambeva* species apparently have considerable vagility, occurring in several parallel coastal basins along the south/southeastern/northeastern Brazilian realm (Fig. 1). This may be due to their occurrence in coastal river basins that may allow dispersion via the lower courses of rivers, perhaps during periods of lower sea level, facilitating the colonization of wide areas. Interestingly, a similar situation occurs with the glanapterygine *Listrura* (Villa-Verde *et al.* 2013).

The distribution and diversity of *Microcambeva* seem to be larger than presently known. A possibly new species of this genus was found between the geographical limits of *M. draco* and *M. barbata* in the Rio Doce basin. The three described species of *Microcambeva* occupy specific biotopes. *Microcambeva ribeirae* is known to occur in the middle sections of rivers, within a restricted altitudinal region, with no records in lower stretches of the river basin (W.J.E.M. Costa *pers. comm.*). *Microcambeva barbata* is recorded in middle and lower sections of forested streams, associated with clear waters with middle grain sandy bottoms preferably in shaded areas (Bockmann & Lima 2008). While *Microcambeva draco* occupies a singular biotope, shallow streams with clear waters, moderate current with sandy or gravel bottom; the species is considered rare (Sarmiento-Soares *et al.* 2009).

Cryptic inhabitants of sandy environments are particularly numerous among the Trichomycteridae, specially within Sarcoglanidinae and Glanapteryginae subfamilies (de Pinna & Winemiller 2000). Sarcoglanidines *Microcambeva* and *Ammoglanis* are strongly associated with sand (Schaefer *et al.* 2005). Morphological specializations for life in interstitial sand are shared by all four *Microcambeva* species, such as the reduced body pigmentation, large eye size and narrow caudal peduncle (Adriens *et al.* 2011). Translucent bodies are typical of the fish species dwelling on open, sandy bottoms (Carvalho *et al.* 2006; Zuanon *et al.* 2006). Well developed opercular and interopercular odontodes, externally prominent on head, and fewer in number, as present in *Microcambeva* species, are also observed in other interstitial trichomycterids, such as *Ammoglanis pulex* (de Pinna & Winemiller 2000). The habitat preference of *Microcambeva* sp. specimens from the Rio Doce basin suggests a life in interstitial environments along small rivers, with shallow clear waters of moderate current and fine substrate for digging. These psammophile fishes are usually found hidden in sand and their existence is not even known by local fishermen. Additional natural history studies are necessary to better understand their habitat preferences and to suggest measures to conserve the species.

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