

# A new *Centromochlus* Kner, 1858 (Siluriformes: Auchenipteridae: Centromochlinae) from the transition between Amazon floodplain and Guiana shield, Brazil

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Species of *Centromochlus* are widely distributed in South America, with records for major basins such as the Amazon and Orinoco, rivers draining the Guiana Shield such as the Essequibo, Courantyne (Corantijn), Coppename, Maroni, and Oyapock, and Brazilian Shield drainages as upper Paraná and São Francisco. In the last four years, three species of *Centromochlus* have been described, raising the total number of valid species to sixteen. The new species of *Centromochlus* described herein is diagnosed by having black ground color sharply delimited from a white underside by conspicuous wavy border. The new species is recorded from the Nhamundá, left bank tributary to the lower Amazon that drain from the Brazilian portion of the Guiana Shield. Although apparently similar to some *Tatia* species (e.g. *Tatia musaica*, *T. carolae* and *T. melanoleuca*), the new species possess two conditions of the Weberian apparatus otherwise observed only in *Centromochlus heckelii* and *C. existimatus* among centromochlin catfishes. The new *Centromochlus* comprises small catfishes with adults ranging from 48 to 57 mm SL.

Espécies de *Centromochlus* têm ampla distribuição pela América do Sul, com registros para as principais bacias como o Amazonas e Orinoco, rios com drenagens no Escudo das Guianas como Essequibo, Corentyne, Copename, Maroni e Oyapoque, e ainda pelas drenagens do Escudo Brasileiro como Alto Paraná e São Francisco. Nos últimos quatro anos foram descritas três espécies de *Centromochlus* elevando o número de espécies válidas para dezesseis. A nova espécie de *Centromochlus* aqui descrita é diagnosticada pela presença de dorso escuro abruptamente separado de um ventre branco por uma barra ondulada conspícua. A nova espécie foi descoberta no rio Nhamundá um igarapé de água clara do baixo Amazonas com rede de drenagem a partir da porção brasileira do Escudo das Guianas. Apesar de aparentemente similar a algumas espécies de *Tatia* (e.g. *Tatia musaica*, *T. carolae* e *T. melanoleuca*), indivíduos da nova espécie apresentam uma morfologia particular do aparelho de Weber até então reportadas apenas para *C. heckelii* e *C. existimatus*, entre os bagres centromochlíneos, e que merecem maiores discussões. O novo *Centromochlus* inclui pequenos bagres com adultos entre 48 e 57 mm CP.

**Keywords:** Doradoidea, Ostariophysi, South America, Systematics, *Tatia*.

## Introduction

The Auchenipteridae is composed of two monophyletic clades: Centromochlinae and Auchenipterinae (Soares-Porto, 1998; Akama, 2004; Birindelli, 2014). The Centromochlinae is one of the most well-supported clades in Auchenipteridae, and uniquely diagnosed by features associated with reproduction by insemination, such as: anal fin oblique relative to the body axis in mature males, urogenital papilla emerging from skin flap at anal-fin origin in adult males; anal-fin proximal radials partially or completely

fused together forming a single ossification in mature males, and anal-fin proximal radials oblique relative to the body axis in mature males, not interdigitated with hemal spines (Ferraris, 1988, 2003; Soares-Porto, 1998; Birindelli, 2014). The genera *Centromochlus* Kner 1858, *Gelanoglanis* Böhlke 1980, *Glanidium* Lütken 1874 and *Tatia* Miranda Ribeiro 1911, constitute the subfamily Centromochlinae (Ferraris, 2007). In the last five years, several new species have been described in Centromochlinae, including three *Centromochlus*, one *Gelanoglanis*, one *Glanidium*, and three *Tatia*, for a total of 43 valid species within the subfamily.

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Species of *Centromochlus* are widely distributed in South America, occurring in the Orinoco basin in Venezuela and Colombia, Amazon basin from Ecuador to Brazil, coastal rivers of northern South America between the mouths of the Orinoco and Amazon rivers and upper Paraná and São Francisco basins (Soares-Porto, 1998; Ferraris, 2003, 2007; Akama & Sarmiento-Soares, 2007; Sarmiento-Soares & Buckup, 2005; Sarmiento-Soares & Birindelli, 2015).

At present, *Centromochlus* is a morphologically heterogeneous assemblage composed of 15 species supported by the presence of an elongate maxilla that extends into the maxillary barbel; elongate ventrolateral process of infraorbital 1, forming anterior border of orbit; and longitudinal crest on the parasphenoid and orbitosphenoid for attachment of the *adductor arcus palatini* (Soares-Porto, 1998; Sarmiento-Soares & Porto, 2006). In addition, the anterior nuchal plate is lacking in *Gelanoglanis* and some species of *Centromochlus* (Soares-Porto, 1998; Sarmiento-Soares & Birindelli, 2015).

Recent fieldwork along the rio Nhamundá, Amazonas and Pará states, a clearwater tributary of the lower Amazon river draining the Guiana shield, revealed the presence of a new distinctively colored, species of *Centromochlus*.

#### Material and Methods

Osteological features were examined in cleared and stained (CS) specimens prepared according to the procedures of Taylor & Van Dyke (1985). Osteological data were obtained from radiographs for species poorly represented in ichthyological collections. Specimens examined as radiographs are noted as “Rx” in the Comparative Material section. Prior to clearing and staining, specimens were dissected to determine gut contents, sexual maturity of gonads, and myological characteristics. Osteological nomenclature follows the Teleost Anatomy Ontology (Dahdul *et al.*, 2010), with exceptions based on Birindelli (2014). Orientation of dentations on pectoral-fin spine as in Vanscoy *et al.* (2015). Muscle names follow Sarmiento-Soares & Porto (2006). Drawings of cleared and stained specimens were rendered by *camera lucida*. Photographs of structural details were taken using a digital camera coupled to a Leica stereomicroscope.

Straight-line measurements were made with digital calipers to the nearest 0.1 mm. Measurements and counts follow Sarmiento-Soares & Martins-Pinheiro (2008). Counts of fin rays and bony elements were obtained from alcohol-preserved and CS specimens. Vertebral counts include the five elements incorporated into the Weberian complex plus one terminal element associated with the hypural complex (following Vari & Ferraris, 2013). Counts of branchiostegal rays were performed only on CS specimens. Standard length (SL) is expressed in mm and all other measurements are expressed as percentage of the SL, except subunits of the head, which are expressed as percentage of the head length (HL).

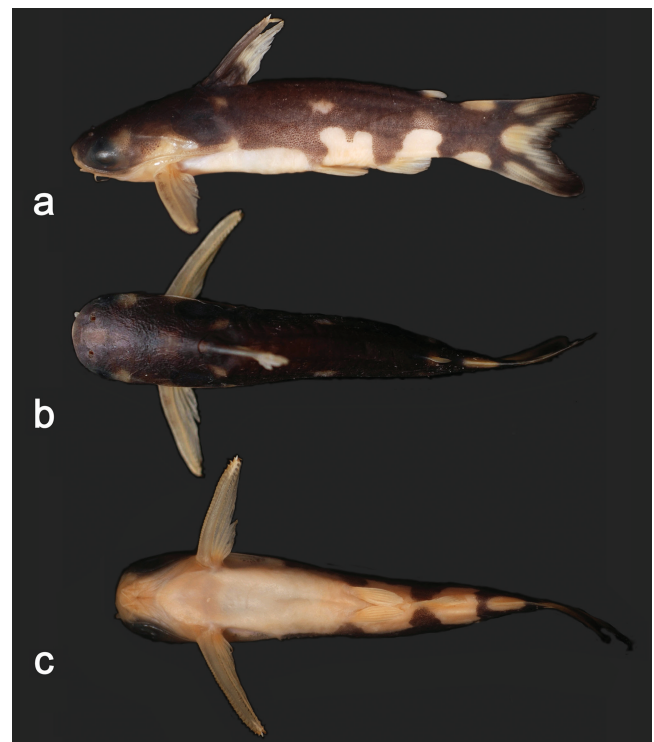
Institutional abbreviations are as follows: American Museum of Natural History, New York (AMNH); The Academy of Natural Sciences of Philadelphia (ANSP); Illinois Natural History Survey, University of Illinois, Champaign, Illinois (INHS); Instituto Nacional de Pesquisas da Amazônia, Manaus (INPA); Instituto Nacional da Mata Atlântica [formerly Museu de Biologia Professor Mello Leitão], Santa Teresa (MBML); Museo de Biología de la Universidad Central de Venezuela, Caracas (MBUCV-V); Museo de Ciencias Naturales de la Universidad de Los Llanos Occidentales Ezequiel Zamora - UNELLEZ, Guanare (MCNG); Museu Nacional, Rio de Janeiro (MNRJ); Museu de Zoologia da Universidade de São Paulo (MZUSP); Netherlands Centre for Biodiversity Naturalis [formerly Rijksmuseum van Natuurlijke Historie], Leiden (RMNH. PISC); National Museum of Natural History, Smithsonian Institution, Washington DC (USNM) and Zoölogisch Museum, Universiteit van Amsterdam [alternatively Zoological Museum Amsterdam], Leiden; now part of Netherlands Centre for Biodiversity Naturalis (ZMA).

#### Results

##### *Centromochlus orca*, new species

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Fig. 1



**Fig. 1.** *Centromochlus orca*, new species, holotype, INPA 50870, female, 56.8 mm SL, mouth of Igarapé Jamari with lago de Terra Santa, rio Nhamundá basin, middle Amazonas basin, Pará State, Brazil. Lateral (a), dorsal (b) and ventral (c) views.

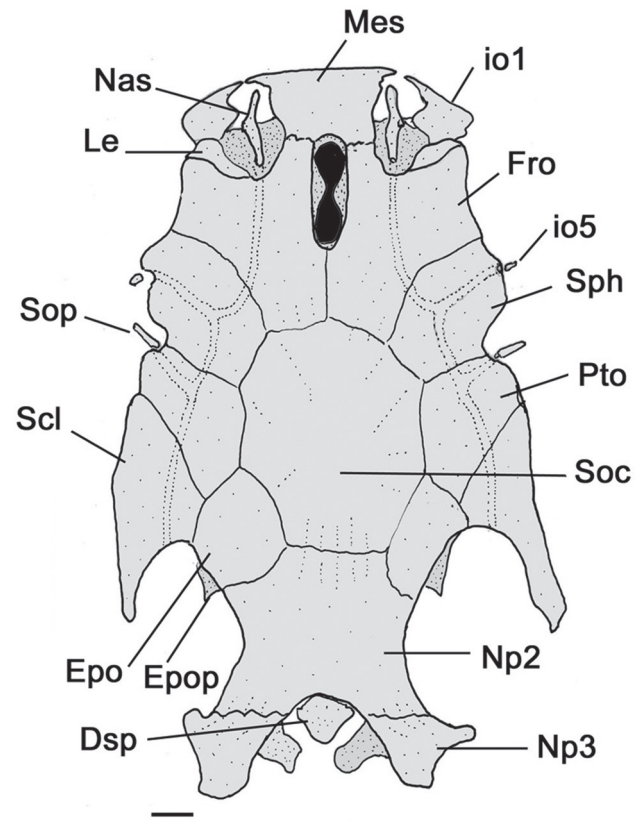
**Holotype.** INPA 50870, 1, 56.8 mm SL, Brazil, Pará, Terra Santa, mouth of Igarapé Jamari with lago de Terra Santa, rio Nhamundá basin, 02°00'04"S 56°31'08"W, 22 Sep. 2009, R. P. Leitão & H. Lazzarotto.

**Paratypes.** All from Brazil. Pará: Terra Santa: INPA 35086, 14 +1 CS, 40.5-56.8 mm SL, INPA 35087, 4, 21.0- 47.7 mm SL, MBML 11220, 1, 51.0 mm SL, MBML 11221, 1 CS, 50.6 mm SL, MNRJ 45072, 5+1 CS, 38.2-52.3 mm SL, MPEG 33927, 3, 39.0-50.8 mm SL, MZUEL 15706, 1, 42.8 mm SL, collected with the holotype. Amazonas: Nhamundá: INPA 43875, 4, 42.7-53.8 mm SL, lagoa Sete Ilhas upstream from Nhamundá, 01°50'28"S 57°04'20"W, 12 Nov. 2013, R. A. Collins. INPA 43883, 3, 37.0-48.1 mm SL, Lagoa Sete Ilhas upstream from Nhamundá, on boundary between Amazonas and Pará, 01°43'04"S 57°22'07"W, 12 Nov. 2013, R. A. Collins.

**Non-type material.** Brazil. Amazonas. Presidente Figueiredo: MZUEL 10467, 11, 25.7-46.2 mm SL, rio Uatumã, near mouth of rio Pitinga, at base WABA of ReBio Uatumã, in the reservoir of UHE, 01°31'19.7"S 69°49'17.9"W, 18 Sep. 2014, J. L. O. Birindelli, F. C. Jerrep, L. Rapp Py-Daniel & V. N. Machado.

**Diagnosis.** *Centromochlus orca* is distinguished from all congeners by its unique color pattern, black ground color sharply delimited from a white underside by conspicuous wavy border. Additional features for recognition of *C. orca* include the absence of anterior nuchal plate (Fig. 2) and eye diameter large, between 24.4 to 29.9% in HL.

The boldly contrasted black and white color pattern is unique to *C. orca*, but a similar pattern is found in *T. musaica*, from rio Orinoco, *T. carolae* Vari & Ferraris 2013, from rio Cuyuni, lower Essequibo, and *T. melanoleuca*, from rio Teles Pires, upper Tapajós. All those species lack the anterior nuchal plate. *Centromochlus orca* is distinguished from *T. musaica* by coloration, as in *C. orca* the pattern is contrasted with white areas extending dorsally onto lower sides of body (vs. a non-pigmented area in a mosaic pattern - compare Figs. 1 and 11). Notable differences among *C. orca* and *T. musaica* are observed in suspensorium bones (compare Figs. 3a and 3b), with contact between metapterygoid and quadrate via suture and cartilage (vs. contact between metapterygoid and quadrate via cartilage only in *T. musaica*), and hyomandibula broad, with a well developed medial lamina (vs. hyomandibula notched, lacking medial lamina in *T. musaica*). The color pattern in *C. orca* is contrasting as black and white colors, differing from the faint coloration in *T. carolae* and *T. melanoleuca* (see Vari & Calegari, 2014, fig. 1; Vari & Ferraris, 2013, fig. 1). *Centromochlus orca* is further distinguished from both *T. melanoleuca* and *T. carolae* by shape of Müllerian ramus disc (bulbous in *C. orca* vs. spoon shaped in *T. melanoleuca* and *T. carolae*) (compare Figs. 4a and 4b). For further details, see discussion.



**Fig. 2.** Neurocranium of *Centromochlus orca*, INPA 35086, paratype, 54.1 mm SL. Dorsal view. Abbreviations: **Dsp**, dorsal fin spinelet; **Epo**, epiotic; **Epop**, epiotic process; **Fro**, frontal; **io1**, first infraorbital; **io5**, posterior ossified infraorbital; **Le**, lateral ethmoid; **Mes**, mesethmoid; **Nas**, nasal; **Np2**, middle nuchal plate; **Np3**, posterior nuchal plate; **Pto**, pterotic; **Scl**, posttemporal-supracleitrum; **Soc**, parieto-supraoccipital; **Sop**, suprapreopercle; **Sph**, sphenotic. Scale bar = 1 mm.

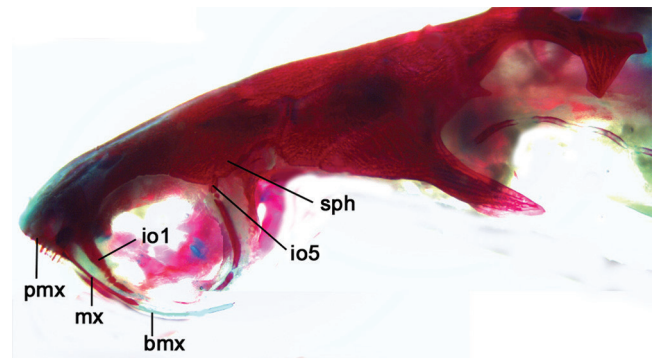
**Description.** Morphometric data presented in Table 1. Small size, adult specimens 47.7-56.8 mm SL. Body almost cylindrical from rear of head through abdomen and gradually compressed towards caudal fin. Dorsal profile slightly convex from snout tip to dorsal-fin origin, approximately straight from that point to vertical through pelvic-fin origin, slightly convex to adipose-fin terminus, then slightly concave on caudal peduncle. Greatest body width at pectoral-fin origin, 19.4-22.1% SL. Ventral profile of body gently concave between anal-fin base and caudal-fin origin. Greatest body depth at origin of dorsal fin, 17.3-20.8%SL. Head integument thick, obscuring bones of cranial roof; eyes large, laterodorsal on anterior portion of head, covered by thick layer of translucent skin. Snout margin broadly rounded in dorsal view; anterior nostril close to snout margin, with tubular skin flap anteriorly oriented; posterior nostril also with tubular skin flap, located at vertical through anterior border of orbit; transverse distance between anterior nostrils almost equal to distance between posterior ones. Three pairs of

barbels: maxillary, inner and outer mental. Maxillary barbel short, surpassing membranous border of opercle, reaching approximately vertical through dorsal-fin origin; adpressed maxillary barbel fits in groove on lateral portion of head, immediately above rictal fold and below eye; mental barbels short, tips not reaching pectoral-fin base; barbels arranged in arc along ventral surface of jaw; inner mental barbel about half the length of outer one. When adpressed, inner and outer mental barbels received by groove in skin. Posterior process of cleithrum moderately large, almost reaching vertical through middle of dorsal-fin base.

**Table 1.** Morphometric data for *Centromochlus orca*. SD = Standard deviation, N = Number of specimens.

	Holotype	Range	Mean	SD	N
Standard length	56.8	47.6-56.8	51.5	3.4	13
Percent of standard length					
Body depth	18.8	17.5-20.8	19.2	0.9	13
Body width	12.9	18.9-22.3	20.8	1.2	13
Caudal-peduncle depth	19.9	9.9-12.9	11.2	0.8	13
Caudal-peduncle length	22.9	19.3-26.5	23.7	2.2	13
Predorsal length	34.7	32.8-37.8	35.0	1.6	13
Preanal length	68.7	67.8-72.2	69.7	1.3	11
Prepelvic length	56.5	52.7-56.9	55.1	1.9	13
Dorsal to pectoral origin	24.6	20.7-24.8	23.8	1.1	13
Dorsal to pelvic origin	31.5	27.9-34.3	30.9	1.8	13
Pectoral to pelvic origin	36.6	33.8-38.3	36.3	1.2	13
Prepectoral length	22.0	20.0-26.8	22.7	1.7	13
Dorsal-fin base length	12.5	11.1-12.9	12.0	0.6	13
Adipose-fin base length	2.7	2.7-5.1	3.7	0.8	12
Anal-fin base length	7.7	6.1-8.8	7.8	0.9	11
Dorsal-fin spine length	22.2	20.1-24.2	22.2	1.3	11
Pectoral-fin spine length	27.5	25.2-31.1	28.0	1.7	12
Posterior process of cleithrum length	21.3	19.8-24.6	22.1	1.4	13
First branched pelvic-fin ray length	12.9	11.8-14.0	12.8	0.7	13
Longest anal-fin ray	11.4	11.1-12.6	11.7	0.5	11
Maxillary-barbel length	34.0	28.7-37.6	32.9	2.8	12
Outer mental-barbel length	7.7	5.2-11.7	8.2	1.9	12
Inner mental-barbel length	3.7	3.5-7.2	4.8	1.4	12
Head length	25.9	24.8-29.2	26.7	1.5	13
Percent of head length					
Head width	74.8	70.6-77.3	75.3	1.8	13
Head depth	46.3	42-49.1	45.8	2.8	13
Interorbital distance	57.8	53.1-60.3	57.7	2.4	13
Left internarial distance	25.9	20.3-28.7	23.3	2.7	13
Anterior internarial distance	34.7	31.5-37.0	34.5	1.5	13
Posterior internarial distance	32.0	31.5-37.0	34.1	2.0	13
Snout length	33.3	29.1-36.0	32.7	2.4	13
Orbital diameter	24.5	24.4-29.9	26.6	2.0	13
Mouth width	34.7	26.4-34.8	31.6	2.9	13

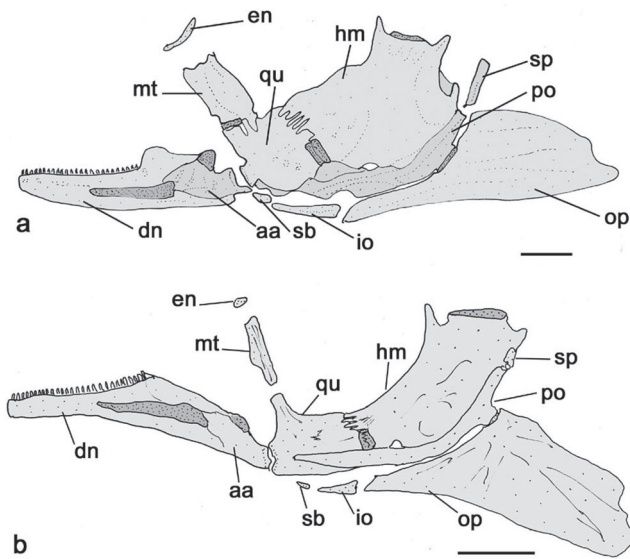
Rostral border of cranium with mesethmoid broader than long; premaxilla with synchondral articulation; cranial fontanel narrow and elliptical, enclosed by mesethmoid and frontals (Fig. 2). Nasal ossified as short tubular bone situated between mesethmoid cornua and lateral ethmoid, not sutured to mesethmoid. Lateral ethmoid not participating in dorsal face of cephalic shield. Autopalatine rod-like, oriented almost parallel to longitudinal axis of body; maxilla slightly elongated, about two-thirds the size of autopalatine (Fig. 3, mx); vomer arrow-shaped with short rostral-lateral processes. Jaws of equal size; premaxilla and dentary slender, each with two or three rows of small conical teeth. Anterior nuchal plate absent; middle nuchal plate slightly concave along lateral margins; posterior nuchal plate short, projected laterally, with prominent tip. Epioccipital process small.



**Fig. 3.** Head in lateral view of a cleared and stained specimen of *Centromochlus orca*, MBML 11221, 50.6 mm SL. Photo by L. Sarmiento-Soares. Abbreviations: **bm**x, maxillary barbel; **io1**, first infraorbital; **io5**, posterior ossified infraorbital; **mx**, maxilla; **pm**x, premaxilla; **sp**h, sphenotic.

Hyomandibular broad, with anteriorly projected lamina, connected to quadrate only, through cartilage and deeply interdigitated suture (Fig. 4a, hm). Quadrate large, trapezoidal, with broad base, sutured to preopercle, hyomandibular and metapterygoid. Metapterygoid somewhat rectangular, as short lamina, joined to quadrate via suture (Fig. 4a, mt); entopterygoid in connective tissue linking metapterygoid to lateral process of vomer (Fig. 4a, en). Long ventral margin of preopercle sutured to both quadrate and hyomandibula; suprapreopercle present as long canal bone; preopercular canal exiting on anterior portion of pterotic. Opercle laminate, ornamented and broadly subtriangular.

Hyoid arch with compact parurohyal with short ventral process; short dorsal hypohyal associated with comparatively large ventral hypohyal (Fig. 6, vh); anterior ceratohyal more developed than posterior ceratohyal. Six branchiostegal rays articulated with hyoid arch, four slender rays associated with anterior ceratohyal, two flattened rays with posterior ceratohyal (Fig. 6, br). Branchiostegal membrane broadly united to isthmus.



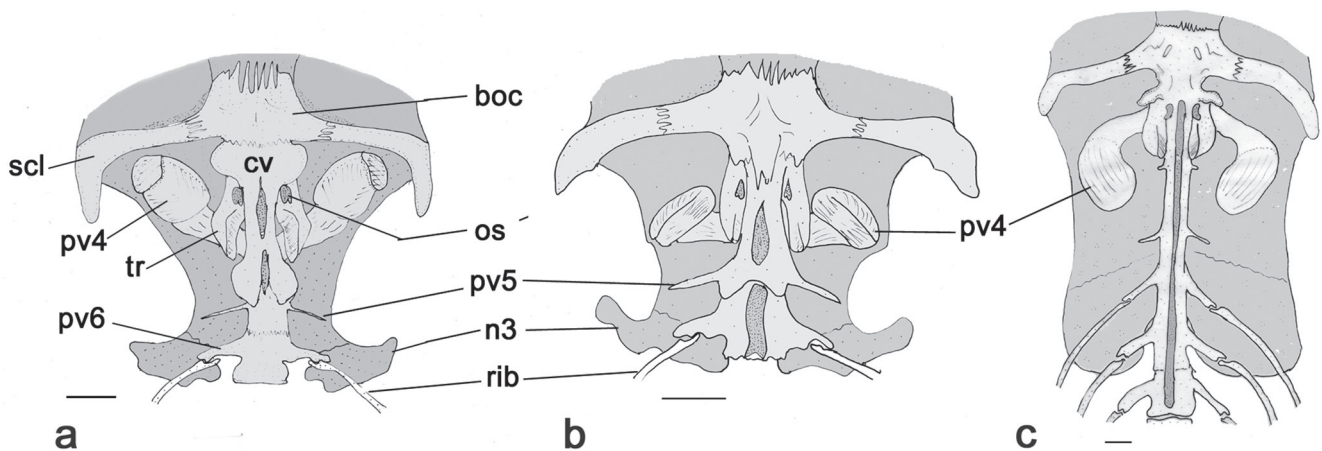
**Fig. 4.** Right suspensorium, lateral view, of **a.** *Centromochlus orca*, INPA 35086, paratype, 54.1 mm SL. **b.** *Tatia musaica*, MBUCV-V 17727, paratype, 24.3 mm SL. Abbreviations: **aa**, angulo-articular; **dn**, dentary; **hm**, hyomandibula; **io**, interopercle; **mt**, metapterygoid; **en**, endopterygoid; **op**, opercle; **po**, preopercle; **qu**, quadrate; **sb**, subpreopercle; **sp**, suprapreopercle. Scale bar = 1 mm.

Branchial (gill) arches with urohyal close to basibranchial 2; basibranchial 2 mostly cartilaginous, broadest anteriorly, slightly separated from basibranchial 3 (Fig. 7, bb2); basibranchial 3 shorter, forming osseous rod; basibranchial 4 large, flattened and cartilaginous; basibranchial 2 bordered laterally by cartilaginous head of hypobranchial 1; basibranchial 3 between cartilaginous head of hypobranchial 2 and cartilaginous hypobranchial 3; basibranchial 4 bordered laterally by cartilaginous head of ceratobranchial 4 and caudally by cartilaginous head of

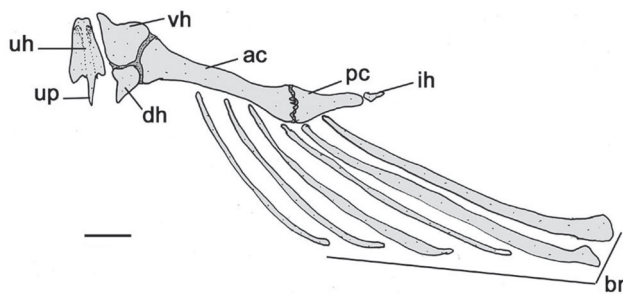
ceratobranchial 5. Hypobranchials 1 and 2 subtriangular, mostly osseous, elongate and expanded laterally, with cartilaginous tips (Fig. 7, hb1, hb2); hypobranchial 3 mainly cartilaginous, trapezoidal; hypobranchial 4 absent. Five ceratobranchials, mostly ossified, with cartilage on both tips (Fig. 7, cb1-5). Ceratobranchials supporting single row of rakers; fifth ceratobranchial expanded postero-medially to support lower pharyngeal toothplate bearing short conical teeth. Four epibranchials, all largely ossified except for cartilaginous tips, each one supporting few rakers, close to articulation with ceratobranchials. Epibranchials 1 and 2 rod-like; epibranchial 3 with posterior uncinuate process articulated to epibranchial 4; epibranchial 4 with laminar extension; reduced accessory cartilage located at angle between cartilaginous tips of epibranchial 4 and ceratobranchial 4. Pharyngobranchial 1 absent; pharyngobranchial 2 short, cartilaginous, somewhat ellipsoid, placed between anteromedial cartilaginous tips of epibranchials 1 and 2; pharyngobranchial 3 elongate, ossified, with expanded posterior border; pharyngobranchial 4 ossified. Upper pharyngeal tooth plate bearing conical teeth, supported by pharyngobranchial 3 and 4, and also epibranchials 3 and 4 (Fig. 7, fb3, fb4).

Müllerian ramus disc of parapophysis of fourth vertebrae with enlarged tip forming bulbous projection, directed posteriorly, extending into lumen of swim bladder (Fig. 5a, pv4).

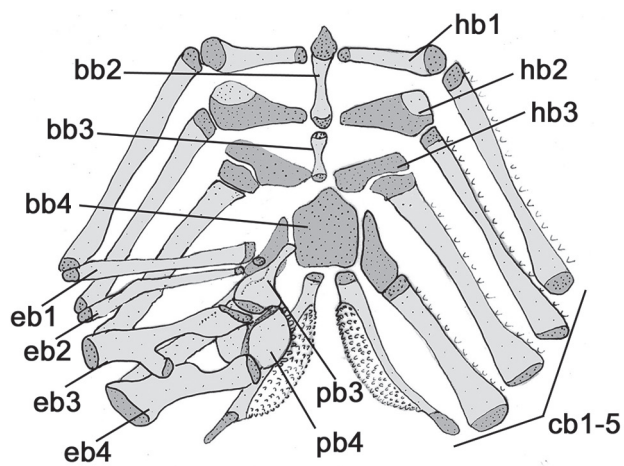
Laterosensory cephalic canal with infraorbital 1 bearing a ventrolateral process restricted to anterior border of eye, and followed by four canal-like bones, in incomplete infraorbital series. Dorsal rim of orbit formed mainly by frontal, with sphenotic contributing the posteriormost limit. Infraorbital canal exiting on middle portion of sphenotic. Lateral line weakly sinuous and with ossified canal bones on anteriormost portion of trunk, then approximately straight with singular terminus on base of caudal-fin rays.



**Fig. 5.** Anterior vertebrae and associated bones, ventral view, of **a.** *Centromochlus orca*, INPA 35086, paratype, 54.1 mm SL. **b.** *Tatia melanoleuca*, MZUSP 30585, 53.0 mm SL. **c.** *Centromochlus heckelii*, MZUSP 8336, 62.0 mm SL. Abbreviations: **n3**, posterior nuchal plate, **boc**, basioccipital, **cv**, complex vertebra, **Pv4**, parapophysis of fourth vertebra, **Pv5**, parapophysis of fifth vertebra, **Pv6**, parapophysis of sixth vertebra, **os**, os suspensorium, **rib**, precaudal rib, **scl**, trans-scapular process of posttemporal-supracleithrum, **tr**, tripus. Scale bar = 1 mm.



**Fig. 6.** Right hyoid arch of *Centromochlus orca*, INPA 35086, paratype, 54.1 mm SL. Ventral view. Abbreviations: **ac**, anterior ceratohyal; **br**, branchiostegal rays; **dh**, dorsal hypohyal; **ih**, interhyal; **pc**, posterior ceratohyal; **vh**, ventral hypohyal; **uh**, urohyal; **up**, urohyal ventral process. Scale bar = 1 mm.



**Fig. 7.** Pharyngeal arches of *Centromochlus orca*, INPA 35086, paratype, 54.1 mm SL. Dorsal view. Abbreviations: **bb2-4**, basibranchials 2 to 4 (anterior to posterior); **cb1-5**, ceratobranchials 1 to 5 (anterior to posterior); **eb1-4**, epibranchials 1 to 4 (anterior to posterior); **hb1-3**, hypobranchials 1 to 3; **pb3**, pharingobranchial 3; **pb4**, pharingobranchial 4. Scale bar = 1 mm.

Dorsal fin II,5; dorsal-fin spine strong, slightly shorter than first branched ray, anterior face with about 20 minute dentations becoming progressively smaller towards fin base; posterior face mostly smooth except for 3-8 retrorse dentations distally; fin tip cartilaginous. Pectoral fin I,5. Pectoral-fin spine strong with 25-33 antrorse dentations on anterior face; 20-22 retrorse dentations on posterior face; dentations on both faces become larger towards tip. Pelvic fin i,5, lateral margin rounded. Adipose fin teardrop shaped, with free posterior margin. Anal fin iii,7; anal-fin pterygiophores with eight rod-like proximal radials and six cartilaginous distal radials. Caudal fin moderately forked, lobes with rounded tips, 8+9 principal rays, all rays branched except for outermost ray of upper and lower lobes; 20-22 upper and 17-19 lower procurrent rays.

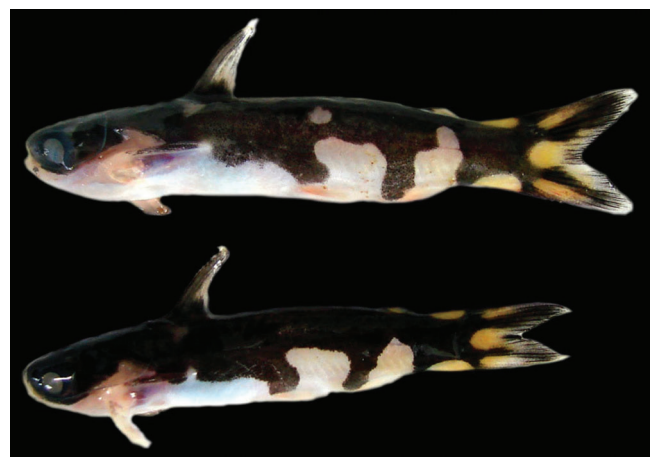
Nine ribs attached to consecutive vertebrae 6-14, becoming progressively smaller posteriorly. Total vertebrae 30 (observed in three cleared and stained specimens).

**Coloration in alcohol.** *Centromochlus orca* has unique color pattern, black ground color sharply delimited from white underside by conspicuous wavy border through lower half of body side. Dorsal cloak uniformly dark or sometimes with white rounded blotch in larger specimens, rounded extensions of dark coloration reach the base of both anal and pelvic fins. Dorsal surface of head also largely black, with tips of third nuchal plate whitish-brown. Latero-ventral sides and belly whitish-yellow, strongly contrasting dark cloak. Posterior process of cleithrum pale to mostly black. Paired and anal fins whitish-yellow with hyaline tips. Dorsal fin with dark base. Dorsal fin spine mostly dark, branched rays hyaline. Adipose fin with dark base and hyaline tips. Caudal peduncle with white half-circle on upper and lower margins. Caudal fin with white circle on fin base; each lobe with pale outer streak and broader dark inner stripe (Fig. 8).



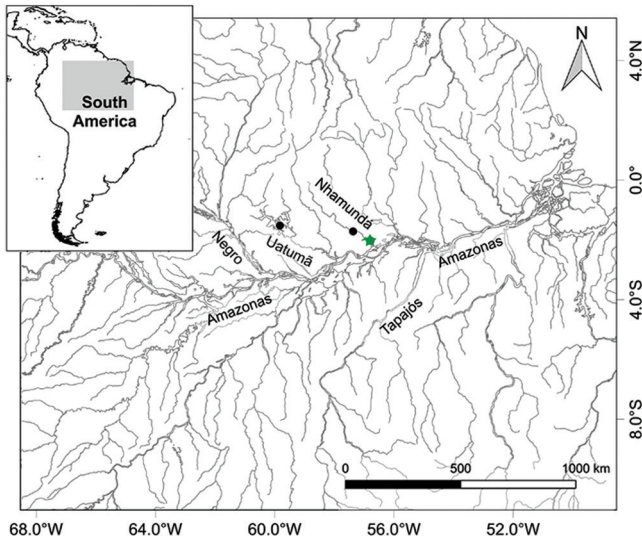
**Fig. 8.** *Centromochlus orca*, MZUEL 10467, 44.8 mm SL, adult male, showing modified anal fin. Photo by J. L. Birindelli.

**Live coloration.** Bold pattern of black and white more highly contrasted than in preserved specimens. Dorsal and lateral surfaces of head with distinctive dark coloration; translucent areas on tip of snout, posterior nuchal plate region, and opercular area. Dark cloak with light rounded blotch present on each side of body between dorsal and adipose fins in large specimens. Belly, anal and paired fins white with traces of pink. Dorsal and pectoral fin spines dark. Adipose fin with dark base and yellow tip. Half circles on caudal peduncle, rounded blotch on caudal-fin base and outer streak on each lobe light-yellow (Fig. 9).



**Fig. 9.** *Centromochlus orca*, new species, just after capture. Photo by H. Lazzarotto.

**Distribution.** *Centromochlus orca* is known from the mouth of Igarapé Jamari, a tributary of the lower rio Nhamundá, in the western Pará, and from two close localities in Lagoa Sete Ilhas upstream from Nhamundá, on the boundary between Amazonas and Pará, in a region along the transition between the Amazonas floodplain and the Guiana Shield (Fig. 10).



**Fig. 10.** Distribution of *Centromochlus orca*. Green star represents type locality.

**Ecological notes.** In the rio Nhamundá basin, the specimens of *C. orca* were collected in the lower portions of Igarapé Jamari, in the transition zone between lotic river habitats and lentic habitats of varzea lakes (Fig. 11). In Igarapé Jamari, the water current was virtually absent. Individuals of *C. orca* were observed actively swimming on the surface or in mid-column in places illuminated by light bulbs close to the shoreline or on boats. All specimens were collected during the night, either by seining (a sandy beach) or with dip nets while swimming (in illuminated areas). Fish assemblages at these localities are highly diverse, encompassing species mainly from the white-water floodplains, but including some taxa typical of clear water rivers that flow from the Guiana Shield, such as *Hoplarchus psittacus*, *Hypancistrus* sp., *Otocinclus mura* and *Peckoltia vittata*. Among the other 151 species collected syntopically with *C. orca*, *Tatia nigra* was the only additional Centromochlinae. Local fishermen reported that *C. orca* is caught and sold for the aquarium trade, but is not a primary target.

**Sexual dimorphism.** Among all specimens examined, none have a fully modified anal fin for insemination. One maturing male exhibited partial modified anal fin (Fig. 8).

**Etymology.** The specific epithet is an allusion to the coloration resembling that of the orca whales (*Orcinus orca*). A noun in apposition.

**Conservation status.** *Centromochlus orca* was recorded for lower portions of rio Nhamundá basin at western Pará, near border with Amazonas state. It corresponds to a species of small fish, with pelagic habits and apparently non migratory. Although reports of specimens caught for aquarium trade, such an activity does not represent a primary target, and possibly does not cause a severe impact in fish natural populations. The species is abundant in the places where it is found and no significant threatening were recognized for the species locally. *Centromochlus orca* was categorized as Least Concern (LC), according to the IUCN criteria for evaluation on threatening status (IUCN, 2016).



**Fig. 11.** Igarapé Jamari, type locality of *Centromochlus orca*, rio Nhamundá basin, middle Amazonas basin, municipality of Terra Santa, Pará State, Brazil. Photo by H. Lazzarotto.

## Discussion

*Centromochlus orca* is promptly distinguished from type species *C. heckelii* and from *C. existimatus*, *C. macracanthus* by having shorter dorsal-fin spine (20-24% vs. 29-35% in SL). Further differs from *C. existimatus* and *C. heckelii*, by having six or seven (vs. 5) branched anal-fin rays and by the bulbous shape of disc portion, the Müllerian ramus, of parapophysis of fourth vertebrae (vs. disc portion elongated, Fig. 5c). Unlike *C. existimatus*, *C. heckelii*, *C. altae* Fowler 1945 and *C. perugiae* Steindachner 1883, *C. orca* lacks an anterior nuchal plate.

Eleven other species of *Centromochlus* share the absence of anterior nuchal plate: *C. meridionalis* Sarmiento-Soares *et al.* 2013, *C. romani* Mees 1988, *C. ferrarisi* Birindelli *et al.* 2015, *C. britskii* Sarmiento-Soares & Birindelli 2015, *C. punctatus* (Mees 1974), *C. bockmanni* (Sarmiento-Soares & Buckup 2005), *C. concolor* (Mees 1974), *C. simplex* (Mees 1974), *C. reticulatus* (Mees 1974), *C. schultzi* Rössel 1962, and *C. macracanthus*. *Centromochlus orca* differs from *C. meridionalis* and *C. romani* by having dentations on the anterior face of dorsal-fin spines (vs. absent). From *C. ferrarisi* and *C. britskii* by having posterior margin of dorsal-fin spine with dentations

(*vs.* smooth); from *C. punctatus* by the long posterior process of cleithrum, length 20.1-23.6% in SL (*vs.* short, 9.5-13.8 % in SL). From *C. bockmanni*, *C. concolor*, *C. simplex*, and *C. reticulatus*, *C. orca* differs by the parapophysis of fourth vertebra, with a particular shape of Müllerian ramus disc posteriorly elongated, slightly extending into lumen of swim bladder (*vs.* Müllerian ramus disc flat, spoon shaped, superficially contacting swim bladder wall only).

Although lacking anterior nuchal plate, *C. orca* is distinguished from *Gelanoglanis* by straight mouth gape, not reaching vertical through eye (*vs.* sinuous, large mouth gape, trespassing vertical through eye); posterior nare opening small, about same size of anterior one (*vs.* posterior nare opening large, about three times in anterior one); eye size more than 20% in HL (*vs.* reductive eyes, less than 10% in HL); two pairs of chin barbels (*vs.* one pair); rostral margin of mesethmoid straight (*vs.* curved); vomer present (*vs.* absent); nasal channel passing through an ossified nasal bone (*vs.* nasal channel free, no ossified bone present); lateral line straight (*vs.* sinuous at least anteriorly); infraorbital canal of cephalic laterosensory system involved in infraorbital ossicles (*vs.* canal free, no ossicles present); mandibular ramus of cephalic laterosensory system within dentary bone (*vs.* free from dentary); premaxillary tooth patches in contact at mesial margin of upper jaw (*vs.* widely separated anteriorly at midline); coronoid process of mandibula straight (*vs.* hook shaped); Müllerian ramus disc of 4<sup>th</sup> parapophysis produced posterior (*vs.* flat, reduced to a small spoon shape).

*Centromochlus orca* differs from remaining centromochlin catfishes in *Glanidium* and most *Tatia*, except *Tatia melanoleuca*, *T. carolae* and *T. musaica* by lacking anterior nuchal plate (*vs.* presence).

Britski (1972) provided the first revision of the auchenipterid catfishes largely based on anatomical features. He noticed that in *Centromochlus heckelii* the parapophysis of fourth vertebrae constituted by a peduncle plus a rounded disc (called Müllerian ramus) formed a bulbous projection into the swim bladder, like a finger into a glove. Latter, this feature was also observed in *C. existimatus* (Soares-Porto, 1998). The vertebrae 1-5 is largely modified into the Weberian complex. In most Doradoidea catfishes, the distal tip of the transverse process of fourth vertebrae, referred as Müllerian ramus by Tavalga (1962), is expanded and broadly contacts the anterior end of swim bladder (Ferraris, 1988). There is considerable variation in the form of Müllerian ramus disc, along with the derivation of associated muscular attachments (Ferraris, 1988). If a gradual variation do exist among species, it remains to be fully investigated. *Centromochlus orca* specimens have a distinctive axial skeleton, with intermediate condition regarding a bulbous Müllerian ramus disc, in which the distal tip of process is elongated (Fig. 7a). The same condition is observed in specimens

of *Tatia musaica*, and in both species it is intermediate between that of *C. heckelii* and *C. existimatus*, in which the Müllerian ramus disc is much elongated, projecting deep into lumen of swim bladder (Fig. 7, pv4). In the remaining *Centromochlus* species the Müllerian ramus is a flattened disc, spoon shaped, resting on the anterior surface of the swim bladder (Fig. 7b). The enlarged tip of Müllerian ramus forming a bulbous projection is unique to *C. orca* and *T. musaica* and questions their placement in different genera. The coloration of *C. orca* resembles that of *T. musaica*, leading to the misidentification of Amazonian specimens as *T. musaica* (compare Figs. 1 and 12).



**Fig. 12.** *Tatia musaica*, MBUCV V-15663, 47.1 mm SL, morphologically similar centromochlin species from the Guiana Shield in Amazonas, Venezuela. Photo by C. DoNascimento and N. Milani. Copyright© F. Provenzano and Museo de Biología de la Universidad Central de Venezuela. Available at <http://acsi.acnatsci.org/>

*Tatia musaica* was originally described in *Tatia* (Royero, 1992), removed to *incertae sedis* in Centromochlinae by Sarmiento-Soares & Martins-Pinheiro (2008) and recently re-assigned to *Tatia* by Vari & Ferraris (2013). An assignment of *T. musaica* to *Tatia* was justified on the basis of caudal peduncle depth greater than 10% SL, a condition that agrees with the diagnosis of *Tatia* (Vari & Ferraris, 2013: 401). Examination of material of *T. musaica*, including types, revealed that it has features that fit both in *Tatia*, such as an intermediate caudal peduncle depth, 7.7-12% in SL, and a deeply notched hyomandibula; and *Centromochlus*, such as elongate maxilla that extends into the maxillary barbel, anterior nuchal plate absent and ventrolateral process of infraorbital 1 forming the anterior border of orbital rim. Regarding the dubious position of *T. musaica* within available genera of Centromochlinae, a reappraisal of phylogenetic relationships within the subfamily is in preparation (LMSS). Based on this ongoing study of centromochlin catfishes, there is some evidence that *T. musaica* and *C. orca* are sister species in a more inclusive *Centromochlus* clade. In this paper we retain *T. musaica* in *Tatia* to avoid confusion, but consider *Tatia* to be a paraphyletic assemblage.

*Centromochlus orca* shares with some *Tatia* species a moderately deep caudal peduncle, 10.4 to 11.8% in SL, a condition found in *T. caxiuanaensis* Sarmiento-Soares & Martins-Pinheiro 2008, *T. gyrina* (Eigenmann & Allen 1942), *T. meesi* Sarmiento-Soares & Martins-Pinheiro



2008, *T. melanoleuca* Vari & Calegari 2014 and *T. musaica* Royero 1992, species with caudal peduncle depth ranging between 9.6-12% in SL (*vs.* between 14-19% in remaining *Tatia*).

We herein assume *T. melanoleuca* as distributed along rio Tapajós, in accordance to rio Jamanxim image reports (Vari & Calegari, 2014) and upon examination of additional material. Regarding the recently described *T. carolae*, *C. orca* is distinguished by its diagnostic black ground color sharply delimited from a white underside by conspicuous wavy border (*vs.* demarcation between dark pigmentation faint delimited from white sides nearly to the ventral midline - Vari & Ferraris, 2013, fig. 1). *Tatia carolae* is much similar to *T. musaica* regarding color pattern, and both species are possibly closely related to *C. orca*.

In addition to features of color pattern, *Centromochlus orca* and *T. musaica* share large eyes (about 26-30% in HL), long maxilla slightly extending into barbel, and dorsal and pectoral fin spines moderately long (20-30% in SL); absence of anterior nuchal plate, and bulbous Müllerian ramus disc (Fig. 7a).

In spite of the similarities with some *Tatia*, the new species is undoubtedly a member of *Centromochlus* due to having maxillary ossification long, penetrating about one third of barbel length (Fig. 3); an elongate ventrolateral process of infraorbital 1, forming anterior border of orbit and a sharp crest forming keel on parasphenoid for attachment of the *adductor arcus palatini*, features hypothesized as derived for genus (Soares-Porto, 1998; Sarmiento-Soares & Porto, 2006).

The distributions of both *C. orca* and *T. musaica* appears to be disjunct. *Tatia musaica* is distributed in the Guiana shield, in tributaries of upper rio Orinoco basin between border of Venezuela and Colombia, and in Roraima, Brazil, in the upper rio Branco, a tributary in the rio Amazonas basin (Royero, 1992; collection data). On the other hand, *C. orca* is found in lowlands at the transition zone between the Guiana Shield and Amazon floodplain in the rio Nhamundá, between Pará and Amazonas states. A notable aspect of the known distribution of *Centromochlus orca* is its apparently disjunct distribution in the rio Nhamundá (type locality) and rio Uatumã, on eastern Amazonas state. Historically, the rio Uatumã may have served as freshwater corridor between the Guiana Shield uplands and lowlands of the lower Amazon. The distributional limits of *T. musaica*, *C. orca* and many other species of Centromochlinae are not clearly understood and additional sampling is necessary to amplify our knowledge of their distributional patterns and historical biogeography.

**Comparative material examined.** *Centromochlus altae*. **Colombia.** USNM 121965, 1, 35.5 mm SL, rio Dedo, tributary of rio Orteguzo. *Centromochlus bockmanni*. **Brazil.** Bahia state. MZUSP 82351, 8, 1 CS, 29.4-35.8 mm SL, paratypes of

*Glanidium bockmanni* Sarmiento-Soares & Buckup, 2005, Rio Preto at Formosa do Rio Preto. *Centromochlus britskii*. **Brazil.** São Paulo State. MZUSP 115271, 39.2 mm SL, MZUSP 43251, 2, 1 CS, 33.5-36.3 mm SL and MNRJ 41787, 2, 36.0-38.6 mm SL, paratypes of *Centromochlus britskii* Sarmiento-Soares & Birindelli, 2015, rio Paraná where is now the Ilha Solteira reservoir, upper rio Paraná basin. *Centromochlus concolor*. **Surinam.** ZMA 106210, 1, 33.4 mm SL, holotype of *Tatia concolor* Mees, 1974, Rx, ZMA 106209, 29.0-30.6 mm SL, paratype of *Tatia concolor* Mees, 1974, Rx, Coppename river. *Centromochlus existimatus*. **Brazil.** Acre State. MZUSP 48880, 1, 90.2 mm SL, Porto de rio Branco, rio Branco. Pará State. INPA 40662, 6, 46.5- 57.9 mm SL, public beach, right margin of rio Xingu, Porto de Moz. *Centromochlus ferrarisi*. **Brazil.** Tocantins State. MNRJ 41924, 1, 57.6 mm SL and MZUSP 115352, 2, 50.4-68.1 mm SL, 1 CS, 68.4 mm SL, paratypes of *Centromochlus ferrarisi* Birindelli, Sarmiento-Soares & Lima, 2015, Rio da Conceição, headwater of Rio das Balsas, Estação Ecológica Serra Geral do Tocantins. *Centromochlus heckelii*. **Brazil.** Acre State. MZUSP 48910, 2, 80.0-83.2 mm SL, rio Acre between seringal Paraíso and lagoa Amapá. Pará State. MZUSP 8336, 2 CS, 53.4-62.0 mm SL, rio Tapajós, Santarém. Amazonas State. INPA 8203, 2, 73.3-81.8 mm SL, Manacapuru. INPA 10967, 2, 106.2-108.7 mm SL, rio Jamari. INPA 8369, 5, 62.3- 74.0 mm SL, rio Amazonas, downstream from Paraná da Eva, Itacoatiara. INPA 12643, 6, 86.7- 90.5 mm SL, rio Jaú, Novo Airão. *Centromochlus macracanthus*. **Brazil.** Amazonas State. INPA 6565, 1, 129.7 mm SL, paratype of *Centromochlus macracanthus* Soares-Porto, 2000, rio Negro. INPA 43009, 6, 55.4- 71.9 mm SL, rio Negro, Cachoeira Curucui, São Gabriel da Cachoeira. MZUSP 30605, 2, 65.7-71.8 mm SL, paratypes of *Centromochlus macracanthus* Soares-Porto, 2000, rio Negro, Cachoeira de São Gabriel, São Gabriel da Cachoeira. *Centromochlus meridionalis*. **Brazil.** Mato Grosso State. MBML 5616, 1 CS, 39.1 mm SL, MBML 5617, 3, 32.2-46.2 mm SL and MNRJ 40702, 3, 32.6-38.3 mm SL, paratypes of *Centromochlus meridionalis* Sarmiento-Soares, Cabeceira, Carvalho, Zuanon & Akama, 2013, Córrego Loanda, a small tributary of rio Roquete, Cláudia. *Centromochlus perugiae*. **Brazil.** Acre State. MZUSP 31880, 1, 28.2 mm SL, Rx, rio Tarauacá, Tarauacá. **Ecuador.** MNRJ 30489, 1, 38.5 mm SL, rio Aguari, Napo. **Peru.** MNRJ 30490, 1, 38.4 mm SL, Huanuco, Amazonas. MZUSP 26029, 2, 22.3-29.8 mm SL, rio Chiriaco, provincia Bagua. MZUSP 26684, 4, 26.2-35.9 mm SL, arroyo de Ivita-Pucallpa, Caserio Neshuya, Provincia Coronel Portillo, Ucayali. *Centromochlus punctatus*. **Brazil.** Pará State. RMNH. PISC 26494, 2, 33.3-43.2mm SL, paratypes of *Tatia punctata* Mees, 1974, Rx, Igarapé Kumadueni, tributary of Rio Paru. **Suriname.** RMNH 26496, 3, 36.2- 39.3 mm SL, paratypes of *Tatia punctata* Mees, 1974, Rx, rivers between Kabel and Lombé. *Centromochlus reticulatus*. **Guyana.** RMNH.PISC 26744, 2, 18.3-39.8 mm SL, paratypes of *Tatia reticulata* Mees, 1974, Rx, Karanambo, Rupununi. *Centromochlus romani*. **Venezuela.** AMNH 91382, 2, 32.5-32.7 mm SL, rio Siapa, Amazonas. INHS 27999, 1, 31.0 mm SL, rio Michay, Apure drainage, Barinas. *Centromochlus schultzi*. **Brazil.** Goiás State. MNRJ 12139, 10 of 38, 1 CS, 85.0-108.9 mm SL, Serra da Mesa dam, upper rio

Tocantins. Mato Grosso State. MNRJ 9417, 2, 32.7-60.8 mm SL, upper rio Xingu. *Centromochlus simplex*. **Brazil**. Mato Grosso State. MZUSP 47506, 1 CS, Igarapé do Aeroporto, Humboldt, Aripuanã. MZUSP 36862, 2, 28.4- 29.6 mm SL, rio Xingu. *Tatia carolae*. **Guyana**. USNM 401514, 37.2 mm SL, holotype of *Tatia carolae* Vari & Ferraris, 2013, Rx, Cuyuni River, sand island in middle of river just downstream from Kurutuku, Essequibo river basin, Cuyuni-Mazaruni. USNM 401511, 1, 31.9 mm SL, paratype of *Tatia carolae* Vari & Ferraris, 2013, Rx, Cuyuni River, sand and gravel beaches downstream from rapids at Kanaima Falls, Cuyuni- Mazaruni. *Tatia melanoleuca*. **Brazil**. Pará State. MNRJ 35521, 1, 48.5 mm SL, rio Tapajós, Mirituba along boat cross at Transamazônica, Itaituba. MZUSP 8535, 6, 1 CS, 46.9-76.5mm SL, rio Tapajós, Santarém. MZUSP 21837, 1, 38.5 mm SL, rio Tapajós, São Luiz. MZUSP 30585, 6, 1CS, 35.0- 48.4 mm SL, rio Tapajós, Alter do Chão. *Tatia cf. melanoleuca*. **Brazil**. Pará State. ANSP 196655, 1, 56.0 mm SL, rio Xingu, 4.5 km northeast of Vitória do Xingu, Senador José Porfírio. ANSP 196655, 1, 44.2 mm SL, rio Xingu, upstream of mouth of rio de Veiros, Porto de Moz. INPA 47841, 2, 49.7- 51.3 mm SL, rio Acarai, about 1 km above confluence with rio Xingu, Porto de Moz. *Tatia musaica*. **Venezuela**. Amazonas. AMNH 58795, 3, 25.1- 29.0 mm SL, paratypes, MBUCV-V 15663, 47.1 mm SL, holotype, MBUCV-V 17727, 1, 24.3 mm SL, paratype of *Tatia musaica* Royero, 1992, rio Atabapo, approximately 3 km from its mouth, San Fernando de Atabapo. ANSP 160656, 1, 57 mm SL, rio Sipapo, above Pendare. MCNG 21796, 1, 50.8 mm SL, caño La Chimita 3-15 km above confluence with rio Atacavi. **Guyana**. ANSP 175836, 9, 22.3- 30.5 mm SL, MNRJ 30491, 1, CS, 23.7 mm SL, Essequibo river. **Brazil**. Roraima state. MZUSP 9347, 1, 29.4 mm SL, rio Uraricoera, Maracá island, near Fazenda Canadá. *Gelanoglanis stroudi*. **Colombia**. Meta department. ANSP 142937, 22.6 mm SL, holotype of *Gelanoglanis stroudi* Böhlke, 1980, ANSP 142938, 5, 25.9-36.6 mm SL, paratypes of *Gelanoglanis stroudi* Böhlke, 1980, Rx, rio Metica approximately 22 km southwest from Puerto Lopez. FMNH 83912, 1, 24.6 mm SL, paratype of *Gelanoglanis stroudi* Böhlke, 1980, CS, rio Manacacias 4 km east from Puerto Gaitan. *Gelanoglanis nanonoticolus*. **Brazil**. Amazonas state. MZUSP 28308, 2, 16-16.8 mm SL, paratypes of *Gelanoglanis nanonoticolus* Soares-Porto, Walsh, Nico & Maia Netto, 1999, Rx, Paraná do Jacaré, rio Negro, Amazon river basin. *Glanidium albescens*. **Brazil**. Minas Gerais State. MNRJ 16262, 4, 107.5-121.5 mm SL, rio Paraopeba, São Francisco river basin.

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