

A new species of *Centromochlus* (Siluriformes, Auchenipteridae, Centromochlinae) from the middle Rio Tocantins basin, Brazil

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A new species of the catfish genus *Centromochlus* (Auchenipteridae, Centromochlinae) is described. The new species is diagnosed by having numerous dark rounded blotches over the body and fins, dorsal-fin spine with serrations anteriorly and smooth posteriorly, anal fin of mature males with three unbranched and seven branched rays, anterior nuchal plate absent and posterior nuchal plate not extended ventrally. The new species is described from a small stream in the Estação Ecológica Serra Geral de Tocantins, a natural reserve in the centre of the Brazilian Cerrado, close to the watershed between the Rio Tocantins and the Rio São Francisco basins. The new species is possibly the sister taxon to the recently described *Centromochlus meridionalis* from the upper Rio Tapajós. Those two species share with *Centromochlus perugiae*, from the upper Amazon and upper Paraguay, derived features associated with the modified anal fin in sexually mature males.

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Key words: Doradoidea; Neotropical; Ostariophysi; systematic; *Tatia*; taxonomy.

INTRODUCTION

The Auchenipteridae is unique among catfishes (Siluriformes) by having insemination through a modified anal fin in mature males (Birindelli, 2014). The family is divided into two subfamilies, Auchenipterinae and Centromochlinae, mainly according to the development of the modified anal fin of mature males (Ferraris, 1988, 2003; Soares-Porto, 1998; Birindelli, 2014). The species of Auchenipterinae have a long anal fin with only the last unbranched and first branched rays of mature males modified to facilitate insemination, and comprises 18 of the 22 genera and *c.* 70 of the 100 valid species of the family (Ferraris, 2007; Eschmeyer, 2014). The Centromochlinae is characterized by having the anal fin of mature males short and entirely modified

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into an intromittent organ. Centromochlinae is less diverse than the Auchenipterinae, comprising *c.* 30 valid species classified in four genera: *Centromochlus* Kner 1858, *Gelanoglanis* Böhlke 1980, *Glanidium* Lütken 1874 and *Tatia* Miranda Ribeiro 1911.

The genus *Centromochlus* was restricted by Mees (1974) to *Centromochlus existimatus* Mees 1974 and *Centromochlus heckelii* (De Philippi 1853) in a taxonomic revision of Auchenipteridae mostly based on specimens from Suriname. In a phylogenetic analysis of the subfamily Centromochlinae, Soares-Porto (1998) recognized *Centromochlus* and *Gelanoglanis* as a monophyletic assemblage, including several species previously assigned to *Tatia*. The clade was proposed on the basis of the following synapomorphies: elongated maxilla, *c.* 35–45% larger than autopalatine; anterior nuchal plate absent; elongated ventrolateral process of first infraorbital, forming the anterior border of the orbit rim, with the infraorbital canal extended through that process to its tip (Soares-Porto, 1998). *Centromochlus* was considered by Soares-Porto (1998) to include *Centromochlus concolor* (Mees 1974), *C. existimatus*, *C. heckelii*, *Centromochlus perugiae* Steindachner 1883, *Centromochlus punctatus* (Mees 1974), *Centromochlus reticulatus* (Mees 1974), *Centromochlus romani* (Mees 1988), *Centromochlus schultzi* Rössel 1962 and *Centromochlus stroudi* (Böhlke, 1980). The last was subsequently transferred back to *Gelanoglanis*, a genus revalidated in the next year (Soares-Porto *et al.*, 1999). *Centromochlus altae* Fowler 1945 was considered as a junior synonym to *C. perugiae* by Soares-Porto (1998), but was later validated by Ferraris (2007). Two species were more recently described in *Centromochlus*, *Centromochlus macracanthus* Soares-Porto 2000 and *Centromochlus meridionalis* Sarmiento-Soares, Cabeceira, Carvalho, Zuanon & Akama 2013. In addition, two species were recently transferred to *Centromochlus*: *Glanidium bockmanni* Sarmiento-Soares & Buckup 2005 (Sarmiento-Soares & Martins-Pinheiro, 2013) and *Tatia simplex* Mees 1974 (Sarmiento-Soares & Birindelli, 2014). Currently, a total of 13 species are considered valid in *Centromochlus*; the type species of the genus, *Centromochlus megalops*, is considered as a *species inquirendae* (Ferraris, 2007).

The species previously recognized as *Gelanoglanis* were considered by Soares-Porto (1998) to be closely related to some of the species of *Centromochlus*, rendering the former a junior synonym of the latter. With the subsequent removal of *Gelanoglanis* from *Centromochlus* by Soares-Porto *et al.* (1999), the latter has become paraphyletic. Although a more inclusive group, composed of *C. romani*, *C. perugiae*, *C. existimatus* and *C. heckelii*, was recognized in the phylogeny Soares-Porto (1998), on the basis of seven derived features, no attempt to reorder *Centromochlus* as a monophyletic assemblage, with exclusion of *Gelanoglanis*, has been attempted to date. Further investigations to address the monophyly of *Centromochlus* and composition are clearly necessary.

Situated in the south-eastern portion of the Tocantins state, Brazil, the Estação Ecológica Serra Geral do Tocantins is the second largest natural reserve within the Cerrado domain, encompassing 716 036 ha, and is contiguous with two other large natural reserves, the Parque Estadual do Jalapão (158 000 ha) and the Parque Nacional das Nascentes do Parnaíba (729 000 ha) (Nogueira *et al.*, 2011). During a recent intensive survey of the vertebrate fauna occurring at the Estação Ecológica Serra Geral do Tocantins, carried out during January and February of 2008 (Nogueira *et al.*, 2011), a new species of *Centromochlus* was collected in a headwater tributary of the Rio das Balsas (itself a tributary of the Rio do Sono, a large affluent of the middle Rio

Tocantins). The aim of the present contribution is to provide a description for this new species of Centromochlinae.

MATERIALS AND METHODS

Osteological features were examined in cleared and stained (CS) specimens prepared according to the procedures of Taylor & Van Dyke (1985). Osteological data from some species poorly represented in ichthyological collections were obtained from radiographs. Specimens that were examined as radiographs are noted as R in the Comparative Material section. Nomenclature of osteological elements is based on Weitzman (1962) and Birindelli (2014); most terms follow the Teleostei Anatomy Ontology (Dahdul *et al.*, 2010). Muscle nomenclature follows Sarmiento-Soares & Porto (2006). Drawings were rendered from digital photographs of a CS specimen.

Straight-line measurements (0.1 mm) were made with a digital calliper. Measurements and counts follow Sarmiento-Soares & Martins-Pinheiro (2008). Standard length (L_S) is expressed in mm and all other measurements are expressed as percentage of the L_S , except subunits of the head, which are expressed as percentage of the head length (L_H). Counts of fin rays and bony elements were obtained from alcohol-preserved and CS specimens. Vertebral counts included all rib-bearing centra and five anteriormost centra lacking ribs, and considered the compound caudal centrum (PU1 + U1) as one element. Counts of branchiostegal rays were performed only on CS specimens. The generic assignment of *Tatia musaica* Royero 1992 follows Vari & Ferraris (2013), even though more data are needed to fully justify this classification.

Institutional abbreviations: AMNH, American Museum of Natural History, New York; INPA, Instituto Nacional de Pesquisas da Amazônia, Manaus; MBML, Museu de Biologia Professor Mello Leitão, Santa Teresa; MNRJ, Museu Nacional, Rio de Janeiro; MZUSP, Museu de Zoologia da Universidade de São Paulo, São Paulo; RMNH, Netherlands Centre for Biodiversity Naturalis (formerly Rijksmuseum van Natuurlijke Historie), Leiden and USNM, National Museum of Natural History, Smithsonian Institution, Washington D.C.

TAXONOMY

CENTROMOCHLUS FERRARISI, NEW SPECIES FIGS 1–7

Centromochlus sp. Lima & Caires, 2011: 235, 244, 245, 248 (Brazil, Tocantins, headwater of Rio das Balsas, Estação Ecológica Serra Geral do Tocantins: occurrence, habitat description).

Holotype

MZUSP 98464 (70.6 mm L_S , mature male), Brazil, Tocantins, Rio da Conceição, headwater of Rio das Balsas, Estação Ecológica Serra Geral do Tocantins, 11° 05' 58" S; 46° 46' 07" W, F. C. T. Lima, R. A. Caires & C. Nogueira, 26 January 2008.

Paratypes

MNRJ 41924 (one specimen, 57.6 mm L_S , female); MZUSP 115352 (two specimens, 50.4 mm L_S , maturing male, 68.1 mm L_S , female; 1 CS, 68.4 mm L_S , mature male); collected with holotype.

Diagnosis

Centromochlus ferrarisi is distinguished from all other Centromochlinae, except *C. meridionalis*, by having dorsal and lateral surfaces of head and body darkly mottled

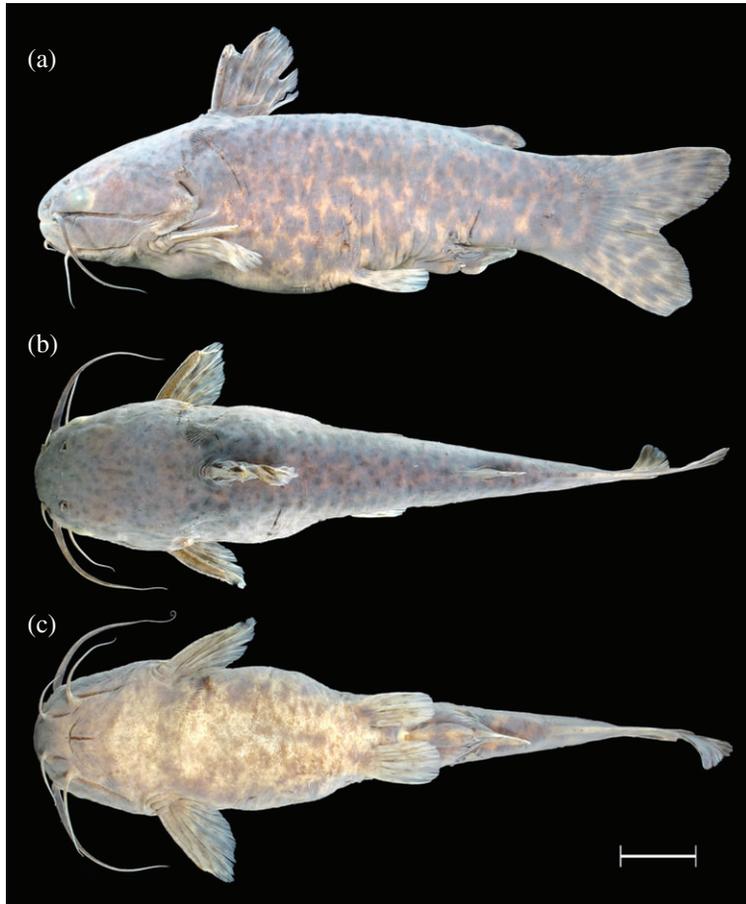


FIG. 1. *Centromochlus ferrarisi*, MZUSP 98464, holotype, male, 70.6 mm standard length, L_S , in (a) lateral, (b) dorsal and (c) ventral views. Scale bar equals 10 mm.

with many small rounded blotches, blotches closely spaced, often coalescent and rather poorly delimited on a pale background (v. dorsolateral surfaces either uniformly dusky or dark, with pale blotches on a darker background, or with a few large dark blotches or spots well spaced and well defined on a pale background). The new species differs from *C. meridionalis* by having the dorsal-fin spine with serrations anteriorly and smooth posteriorly (v. dorsal-fin spine smooth anteriorly and with serrations posteriorly), seven branched anal-fin rays of mature males (v. six) and posterior nuchal plate short, not extended anteroventrally (v. posterior nuchal plate with anteroventral extension). The new species is further distinguished from *C. altae*, *C. existimatus*, *C. heckelii*, *C. meridionalis*, *C. perugiaae*, *C. reticulatus* and *C. romani* by having seven branched anal-fin rays (v. five or six); from *C. macracanthus* and *C. schultzi* by having short pectoral-fin spine, c. 15% of L_S (v. long pectoral-fin spine, 25% of L_S); from *C. concolor* and *C. punctatus* by its short posterior cleithral process, c. 5% of L_S (v. c. 20% of L_S); from *C. altae*, *C. existimatus*, *C. heckelii* and *C. perugiaae* by lacking the anterior nuchal plate (v. present); from *C. romani* by having anterior margin of



FIG. 2. *Centromochlus ferrarisi*, MZUSP 115352, paratypes, (a) female, 68.1 mm standard length, L_S and (b) immature, 50.4 mm L_S , in lateral view. Scale bars equal 10 mm.

dorsal-fin spine with serrations (v. smooth); from *C. simplex* by having adipose fin well developed (v. minute).

Description

Measurements of holotype and paratypes are given in Table I. Dorsal, lateral and ventral views of holotype, male, are presented in Fig. 1. Lateral view of two paratypes, female and immature, is given in Fig. 2. Body relatively short, plump, head approximately rounded in cross section at pectoral-fin spine origin, body depth slightly greater than width at dorsal-fin origin, midbody approximately rounded in cross section, gradually becoming compressed caudally, caudal peduncle depth much greater than width. Dorsal profile gently convex from snout tip to dorsal-fin origin, approximately straight from latter point to vertical through pelvic-fin origin, gently convex from latter point to adipose-fin terminus and slightly concave on caudal peduncle. Ventral profile convex from snout tip to isthmus, relatively straight to slightly convex from isthmus to pelvic-fin origin, straight from latter point to anal-fin terminus and slightly concave on caudal peduncle. Greatest body depth slightly posterior to vertical through middle of distance between origins of pectoral and pelvic fins. In dorsal view, snout broadly rounded.

Mouth terminal, jaws equal. Upper and lower jaws covered with numerous minute acicular teeth. Eyes small, dorsolateral, covered by thick layer of translucent skin. Anterior naris close to snout margin, surrounded by tubular skin flap anteriorly oriented; posterior naris also surrounded by tubular skin flap, located at vertical through anterior border of orbit. Three pairs of barbels: maxillary, inner and outer mental. Maxillary barbel relatively short, origin slightly dorsal to mouth-gap rictus, tip finishing approximately at vertical through dorsal-fin origin. When folded, maxillary barbel received

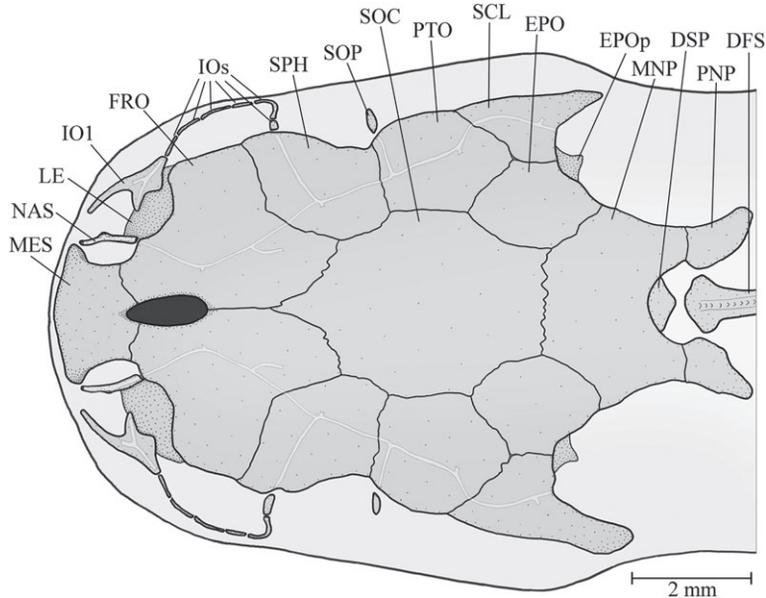


FIG. 3. Cephalic shield bones in dorsal view of *Centromochlus ferrarisi*, drawing based on MZUSP 115352, male, 68.4 mm standard length, L_S . DFS, dorsal-fin spine; DSP, dorsal-fin spinelet; EPO, epiotic; EPOp, epiotic process; FRO, frontal; IO1 and IOs, infraorbitals; LE, lateral ethmoid; MES, mesethmoid; MNP, middle nuchal plate; NAS, nasal; PNP, posterior nuchal plate; PTO, pterotic; SCL, post-temporal-supracleitrum; SPH, sphenotic; SOC, parieto-supraoccipital; SOP, supraopercle.

for almost its entire length by a deep groove along lateral face of head. Inner mental barbel shortest, approximately half the length of outer mental barbel and one-third to one-fourth that of maxillary barbel, origin near anterior margin of lower jaw. Outer mental barbel relatively short, origin at vertical through anterior border of eye, terminus falling short of origin of pectoral-fin spine. When folded, inner and outer mental barbels received by groove in skin on ventral face of head.

Head covered by thick skin layer, bones hardly visible in alcohol-preserved specimens. Dorsal contour formed by short and wide mesethmoid, its posterior margin bordering elongated fontanel, almost completely enclosed by frontals (Fig. 3). Nasal developed as an ossified rod; first infraorbital with anterior portion thin and elongate and followed by six ossifications (infraorbitals); three pores between first infraorbital and sphenotic. Lateral ethmoid not participating in dorsal face of cephalic shield. Dorsal rim of orbit formed mainly by frontal, with sphenotic forming the posteriormost limit. Infraorbital canal exiting on anterior portion of sphenotic. Preopercular canal exiting on anterior portion of pterotic. Anterior nuchal plate absent. Posterior nuchal plate short with rounded posterior margin (not extended anteroventrally).

Six or seven branchiostegal rays (distinct count on each side of the CS examined specimen); branchiostegal membrane broadly united to isthmus. Gill opening relatively small, extending from pectoral-fin spine origin to midpoint between posterior naris and dorsal border of eye. First two gill arches with one row of acicular rakers, following two arches with two rows of rakers, fifth gill arch with one anterior row of rakers; small acicular teeth on fifth ceratobranchial and on pharyngobranchial tooth plate. First pair

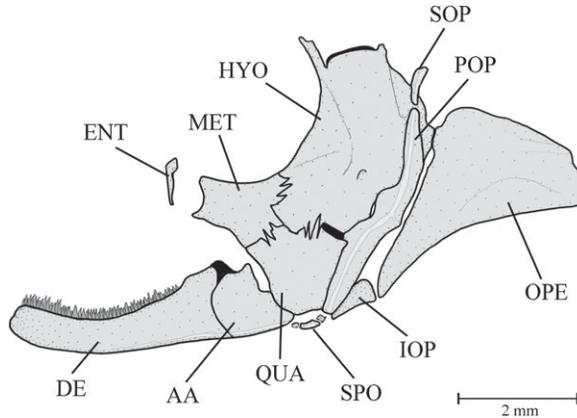


FIG. 4. Suspensorium skeleton in lateral view of *Centromochlus ferrarisi*, drawing based on MZUSP 115352, male, 68.4 mm standard length, L_S . AA, angulo-articular; DE, dentary; ENT, entopterygoid; HYO, hyomandibular; IOP, interopercle; MET, metapterygoid; OPE, opercle; POP, preopercle; QUA, quadrate; SOP, suprapreopercle; SPO, subpreopercle.

of hypobranchials ossified as a small bar, second pair of hypobranchials ossified as rounded plate, last two cartilaginous.

Suspensorium with hyomandibular relatively large, with elongated process anterior to condyle connected to cranium, ventrally sutured to metapterygoid and quadrate

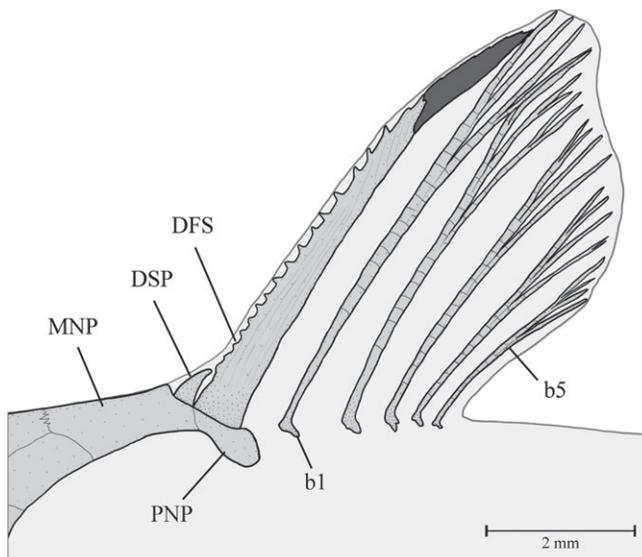


FIG. 5. Dorsal-fin rays and cephalic-shield bones in lateral view of *Centromochlus ferrarisi*, drawing based on MZUSP 115352, male, 68.4 mm standard length, L_S . b1, first dorsal-fin branched ray; b5, fifth dorsal-fin branched ray; DFS, dorsal-fin spine; DSP, dorsal-fin spinelet; MNP, middle nuchal plate; PNP, posterior nuchal plate.

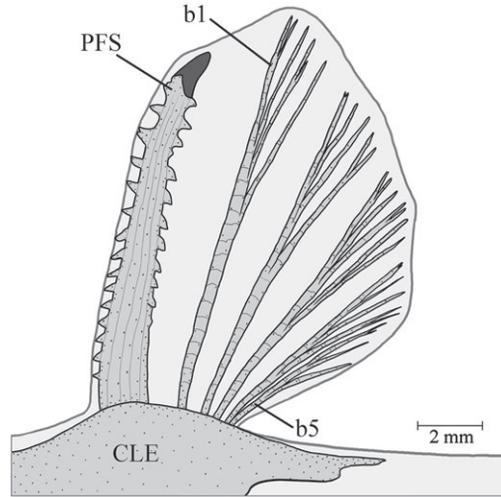


FIG. 6. Pectoral-fin rays in dorsal view, right side of body, of *Centromochlus ferrarisi*, drawing based on MZUSP 115352, male, 68.4 mm standard length, L_S . b1, first pectoral-fin branched ray; b5, fifth pectoral-fin branched ray; CLE, cleithrum; PFS, pectoral-fin spine.

(Fig. 4). Metapterygoid subtriangular, ventrally sutured to quadrate; entopterygoid in connective tissue linking metapterygoid to lateral process of vomer.

Dorsal fin composed of dorsal-fin spinelet, dorsal-fin spine and five branched rays (Fig. 5). Dorsal-fin spine strong and relatively short, smaller than first branched ray; tip cartilaginous; serrations on anterior face, serrations retrorse near base and antrorse near tip; posterior face smooth. Pectoral fin composed of one spine and five branched rays. Pectoral-fin spine strong with serrations on anterior face, serrations retrorse on basal two-thirds of spine and antrorse near tip; retrorse serrations on posterior face; serrations on both faces larger towards tip (Fig. 6). Posterior process of cleithrum

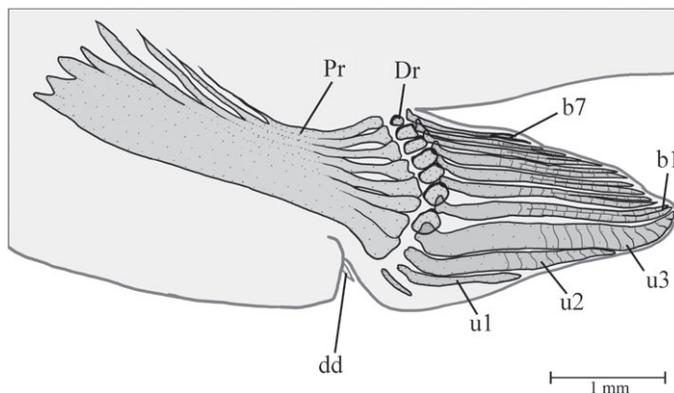


FIG. 7. Anal-fin rays in lateral view of a mature male of *Centromochlus ferrarisi*, drawing based on MZUSP 115352, 68.4 mm standard length, L_S . b1, first anal-fin branched ray; b7, seventh anal-fin branched ray; dd, deferent duct; Dr, distal radial; Pr, proximal radial; u1–3, first, second and third anal-fin unbranched rays.

TABLE I. Morphometric data for *Centromochlus ferrarisi* new species

	<i>n</i>	Mean \pm S.D.	Range	Holotype
Standard length (L_S ; mm)	5		50.4–70.6	70.6
Percentages of L_S				
Body depth	5	27.67 \pm 2.09	24.40–29.24	28.90
Body width	5	25.62 \pm 0.81	24.40–26.58	25.35
Caudal peduncle depth	5	16.38 \pm 0.66	15.28–17.00	17.00
Caudal peduncle length	5	21.39 \pm 1.57	19.09–23.51	23.51
Predorsal length	5	34.29 \pm 0.76	33.53–35.41	35.41
Preanal length male	2	76.91 \pm 0.20	76.77–77.05	76.77
Preanal length female	3	69.74 \pm 0.52	69.44–70.34	–
Prepelvic length	5	56.34 \pm 1.13	55.41–58.30	55.95
Dorsal origin to pectoral origin	5	26.23 \pm 1.00	25.35–27.90	27.90
Dorsal origin to pelvic origin	5	35.70 \pm 2.88	32.54–38.67	38.67
Pectoral origin to pelvic origin	5	36.69 \pm 1.19	34.94–38.03	36.69
Prepectoral length	5	24.57 \pm 0.80	23.83–25.69	24.22
Dorsal-fin base length	5	10.44 \pm 0.58	10.06–11.46	10.06
Adipose-fin base length	5	9.59 \pm 1.06	8.33–10.87	10.48
Anal-fin base length male	2	4.89 \pm 0.30	4.68–5.10	5.10
Anal-fin base length female	3	9.12 \pm 0.34	8.73–9.38	–
Dorsal-fin spine length	5	12.90 \pm 0.80	11.71–13.74	12.75
Pectoral-fin spine length	5	14.00 \pm 1.67	11.31–15.63	13.74
Posterior process of cleithrum length	5	5.29 \pm 0.42	4.76–5.90	5.10
First branched pelvic-fin ray	5	13.57 \pm 0.73	12.70–14.58	13.60
Longest anal-fin ray male	2	10.64 \pm 0.37	10.38–10.91	10.91
Longest anal-fin ray female	3	13.33 \pm 0.98	12.33–14.29	–
Maxillary-barbel length	5	31.76 \pm 4.42	25.35–36.98	25.35
Outer mental barbel length	5	13.27 \pm 3.60	7.74–16.67	12.18
Inner mental barbel length	5	7.68 \pm 0.99	6.37–8.52	6.37
Head length (L_H)	5	28.83 \pm 1.17	27.18–30.25	29.32
Percentages of L_H				
Head width	5	75.69 \pm 2.12	72.99–78.76	76.33
Head depth	5	40.53 \pm 1.66	38.69–42.49	42.03
Interorbital distance	5	53.28 \pm 2.42	50.60–56.48	55.07
Left internarial distance	5	15.25 \pm 1.83	12.62–17.62	15.94
Anterior internarial distance	5	30.52 \pm 2.20	27.18–33.33	33.33
Posterior internarial distance	5	30.84 \pm 2.21	27.18–33.16	30.92
Snout length	5	36.39 \pm 1.54	34.72–38.10	37.68
Orbital diameter	5	15.20 \pm 1.58	13.11–17.52	15.46
Mouth width	5	51.19 \pm 2.67	47.57–54.01	53.14

relatively small, elongated with acute tip finishing at vertical through base of dorsal-fin spine. Pelvic fin composed of one unbranched plus five branched rays; subtriangular with distal margin rounded. Anal fin with three unbranched and seven branched rays. Female and immature specimens with anal fin approximately semicircular. Anal-fin pterygiophores rod-like and generally forming a 45° angle with body axis, posterior-most ray parallel to body axis. Anal fin of mature males described below. Adipose fin tear-drop shaped, with free posterior margin. Caudal fin forked, with rounded and

approximately equal lobes; principal rays with dorsalmost and ventralmost unbranched and seven branched rays on dorsal lobe and eight on ventral lobe.

Lateral line weakly sinuous on anteriormost portion of trunk, approximately straight beyond with singular terminus on base of caudal-fin rays (*e.g.* not bifurcated as in *Ageneiosus*). Gas bladder abbreviated heart-shaped, relatively large, occupying most of anterodorsal portion of visceral cavity; internal T-shaped septum well developed, completely dividing posterior half into separate chambers, which are partially separated from single anterior chamber. Thirty-five vertebrae; sixth to 14th centra-bearing ribs; fifth, sixth and seventh sutured to complex vertebra.

Sexual dimorphism

Two mature males of *C. ferrarisi* (68.4 and 70.6 mm L_S) known based on possession of completely modified anal fin (morphology similar to mature male of congeners) (Fig. 7). The smallest specimen (50.4 mm L_S) has anterior margin of anal fin straight (similar to mature males; *v.* convex in females), and last unbranched ray with distal lepidotrichia slightly enlarged (also resembling mature males, *v.* not enlarged, similar to branched rays in females), indicating that it might be a maturing male. Mature males with anus at base of anal fin, and deferent duct enlarged and externally visible as a genital papilla; anal fin triangular, with acute distal tip oriented posteriorly; eight proximal radials fused together, although sutures visible (in CS specimen) between last two or three elements; seven distal radials, last one partially cartilaginous. Anal fin of mature males with three unbranched rays preceded by small ossified element; latter and first unbranched ray unsegmented, second and third unbranched rays segmented; third unbranched ray with enlarged lepidotrichia, distally tip dorsally curved; seven branched rays decreasing in size posteriorly. In some Auchenipteridae, mature transformed males have stiff, ossified maxillary barbels, an elongated dorsal-fin spine and arched cephalic shield covered with unculiferous tubercles (Ferraris & Vari, 1999; Reis & Borges, 2006; Ribeiro & Rapp Py-Daniel, 2010); no such modifications were observed in *C. ferrarisi*.

Colour in alcohol

Head and body countershaded, with ground colour brown dorsally and tan ventrally (Figs 1 and 2). Head and body with numerous (*c.* 100 on each side) dark blotches, somewhat rounded, roughly as large as eye, many coalescing. Ventral portion of head and belly dusky, with scattered dark widespread chromatophores not forming blotches. All fins with coloration similar to the adjacent body region, therefore with dark blotches, especially on caudal fin. Caudal fin with base of rays dark, forming a vertical bar separating caudal peduncle from caudal fin. Maxillary barbel brown with dark blotches; mental barbels tan with widespread chromatophores, not blotched. Live colouration similar to that described above for preserved specimens.

Distribution

Centromochlus ferrarisi is only known from its type locality, a headwater of Rio das Balsas, a tributary of the Rio do Sono, middle Rio Tocantins basin, Tocantins state, Brazil (Fig. 8).

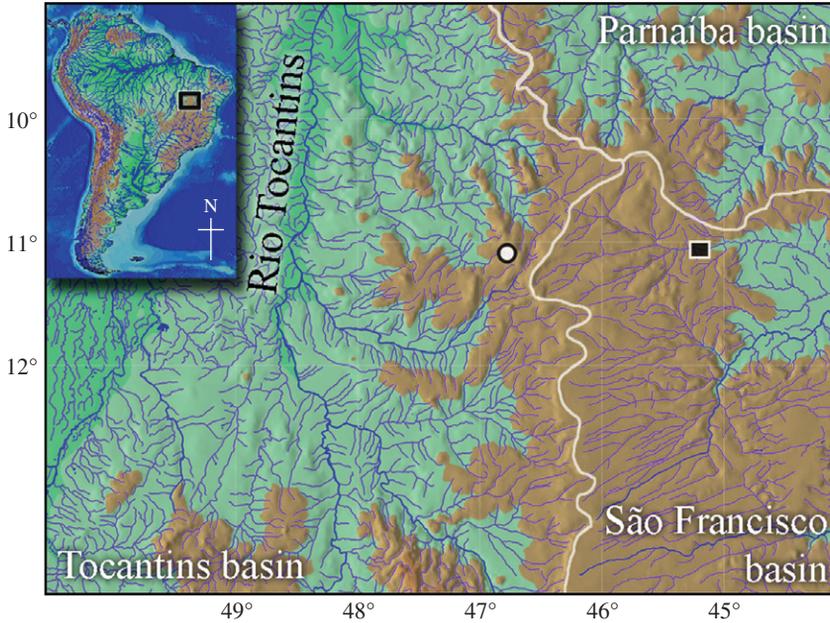


FIG. 8. Map of central portion of Brazil showing watershed divides between the Rio Tocantins, Rio Parnaíba and Rio São Francisco basins, the type locality of *Centromochlus ferrarisi* (O), and a collection site of *Centromochlus bockmanni* (■), Watershed (—).

Ecological notes

The type locality of *C. ferrarisi* is a small headwater stream, 1–1.5 m wide, 0.3–1.0 m deep, with moderate current, bottom sand–silt, with pebbles in some stretches. During collection, the water was mostly clear, with some suspended particulate matter. At the type locality, the stream crosses a sandstone outcrop, forming a small canyon. A narrow riparian forest is present below the small canyon. All specimens of *C. ferrarisi* were collected near submerged logs, and were captured by overturning a log with the hand-net positioned immediately below. The only fishes collected syntopically with *C. ferrarisi* were *Knodus* cf. *savannensis* (Characidae), two species of *Phenacorhamdia* (Heptapteridae), and *Melanorivulus* cf. *zygonectes* (Rivulidae) (Lima & Caires, 2011: 248).

Etymology

Centromochlus ferrarisi is named in honour of C. J. Ferraris Jr., for his numerous contributions to the systematics of Siluriformes, especially Auchenipteridae, including the first hypothesis recognizing Centromochlinae as sister to all other Auchenipteridae.

COMPARATIVE MATERIAL

Centromochlus altae USNM 121965 (one specimen, 35.5 mm L_S), Colombia, Río Dedo, tributary of Río Orteguaiza. *Centromochlus bockmanni* MNRJ 25798 (one specimen, 27.5 mm L_S), Brazil, Minas Gerais, Rio Jequitaiá, at Jequitaiá, close to Francisco Dumont; MZUSP 36976 (one specimen, 37.2 mm L_S), Brazil, Minas

Gerais, Rio São Francisco, downstream from Três Marias dam. MZUSP 82351 (eight specimens, 29.4–35.8 mm L_S ; 1 CS), Brazil, Bahia, Rio Preto at Formosa do Rio Preto. MZUSP 82804 (one specimen, 41.4 mm L_S ; 1 CS), Brazil, Minas Gerais, Rio São Francisco, downstream from Três Marias dam. *Centromochlus* cf. *concolor* MZUSP 31878 (one specimen, 48.7 mm L_S), Brazil, Pará, Rio Tapajós, Alter do Chão. MZUSP 8535 (six specimens, 46.5–76.5 mm L_S ; 1 CS), Brazil, Pará, Rio Tapajós, Santarém. *Centromochlus existimatus* MZUSP 48880 (one specimen, 90.2 mm L_S), Brazil, Acre, Porto de Rio Branco, Rio Branco. *Centromochlus heckelii* MZUSP 48910 (two specimens, 80.0–83.2 mm L_S), Brazil, Acre, Rio Acre between Seringal Paraíso and Lagoa Amapá. MZUSP 8336 (2 CS), Brazil, Pará, Santarém, Rio Tapajós. INPA 8203 (two specimens, 73.3–81.8 mm L_S), Brazil, Amazonas, Manacapuru. INPA 10967 (two specimens, 106.2–108.7 mm L_S), Brazil, Rondônia, Rio Jamari. *Centromochlus macracanthus* INPA 6565 (one specimen, 129.7 mm L_S), Brazil, Amazonas, Rio Negro. MZUSP 30605 (two specimens, 65.7–71.8 mm L_S), paratypes, Brazil, Amazonas, Cachoeira de São Gabriel, Rio Negro. *Centromochlus meridionalis* INPA 37893 (10 specimens, 40.4–47.9 mm L_S), paratypes, Brazil, Mato Grosso, Córrego Loanda, a small tributary of Rio Roquete. INPA 37897 (2 CS, 29.7–39.2 mm L_S), paratypes, Brazil, Mato Grosso, Córrego Loanda, a small tributary of Rio Roquete; MBML 5617 (three specimens, 32.2–46.2 mm L_S), Brazil, Mato Grosso, Cláudia, Córrego Loanda, a small tributary of Rio Roquete. *Centromochlus perugiae* MZUSP 31880 (one specimen, 28.2 mm L_S), Brazil, Acre, Tarauacá, Rio Tarauacá. MNRJ 30489 (one specimen, 38.5 mm L_S), Ecuador, Napo, Río Aguarico; MNRJ 30490 (one specimen, 38.4 mm L_S), Peru, Amazonas, Huanuco. MZUSP 26684 (four specimens, 26.2–35.9 mm L_S), Peru, Ucayali, Coronel Portillo, Arroyo de Ivita-Pucallpa at Caserio Neshuya. *Centromochlus punctatus* RMNH 26494 (two specimens, 33.3–43.2 mm L_S), paratypes, Brazil, Pará, Igarapé Kumadueni, tributary of Rio Paru de Oeste; RMNH 26496 [three specimens (radiographed), 36.2–39.3 mm L_S], paratypes, Suriname, rivers between Kabel and Lombé. *Centromochlus reticulatus* RMNH 26744 [two specimens (radiographed), 18.3–39.8 mm L_S], paratypes, Guyana, Rupununi, Karanambo. *Centromochlus romani* AMNH 91382 (two specimens, 32.5–32.7 mm L_S), Venezuela, Amazonas, Río Siapa. *Centromochlus schultzi* MNRJ 12139 (10 of 38 specimens, 85.0–108.9 mm L_S , 1 CS), Brazil, Goiás, Serra da Mesa dam, upper Tocantins River. MNRJ 9417 (two specimens, 32.7–60.8 mm L_S), Brazil, Mato Grosso, upper Rio Xingu basin.

DISCUSSION

Centromochlus ferrarisi is considered a member of *Centromochlus* due to the elongated maxilla, extending into the maxillary barbel (condition also present in *Gelanoglanis*); an elongated ventrolateral process of the first infraorbital, forming anterior border of orbit; a longitudinal keel on the parasphenoid and orbitosphe-noid for attachment of the adductor arcus palatini muscle (Soares-Porto, 1998; Sarmiento-Soares & Porto, 2006). The aforementioned features, however, vary among species of *Centromochlus*. In *C. ferrarisi*, the maxilla is of intermediate size, larger than the autopalatine, a condition found in the species of *Centromochlus* with adult specimens <70 mm L_S , and the anterior nuchal plate is absent. The longitudinal keel on the cranial floor is also variable among species of *Centromochlus*, being

long and sharp in the species with large eyes (eye diameter *c.* 30% of L_H), such as *C. heckelii*, *C. existimatus* and *C. macracanthus*, and weakly developed in the remaining species, including *C. ferrarisi*. An investigation regarding the monophyly of *Centromochlus* is beyond the scope of the present paper, but is currently underway (L. M. Sarmiento-Soares, unpubl. data). In addition, *C. ferrarisi* lacks the features that diagnose *Tatia*, such as an anterodorsally elongated hyomandibula not contacting the narrow metapterygoid (*v.* hyomandibular in contact to metapterygoid *via* dentate suture in *C. ferrarisi*), and the anterior nuchal plate present (*v.* absent in *C. ferrarisi*). *Centromochlus ferrarisi* is distinguished from *Glanidium* by lacking the anterior nuchal plate (*v.* present); and from *Gelanoglanis* by possessing two pairs of mental barbels (*v.* single pair in *Gelanoglanis*), and having a vomer (*v.* vomer absent) (see Soares-Porto *et al.*, 1999 for additional features exclusive to *Gelanoglanis*).

Centromochlus heckelii, *C. schultzi* and *C. simplex* are the only congeners previously known to occur in the Rio Tocantins basin. *Centromochlus heckelii* is easily distinguished from *C. ferrarisi* by having four or five branched anal-fin rays (*v.* seven); large eyes, *c.* 35% of L_H (*v.* small eye, 15% of L_H); elongated dorsal-fin and pectoral-fin spines, 30–35% of L_S (*v.* short spines, 13–14% of L_S). Although *C. schultzi*, *C. simplex* and *C. ferrarisi* share the absence of the anterior nuchal plate and the presence of seven branched anal-fin rays, *C. ferrarisi* is distinguished by having small eyes, 15% of L_H (*v.* eye > 25% of L_H). *Centromochlus ferrarisi* is further distinguished from *C. schultzi* by possessing a small pectoral-fin spine, *c.* 15% of L_S (*v.* long pectoral fin-spine, 25% of L_S); body mottled with numerous relatively small dark blotches, smaller than the eye diameter (*v.* body with fewer relatively large dark blotches and spots, as large as eye diameter); by lacking serrations on the posterior face of the dorsal-fin spine (*v.* six or seven retrorse serrations on posterior face of dorsal-fin spine). *Centromochlus ferrarisi* is further distinguished from *C. simplex* by having body depth >24% of L_S (*v.* body relatively slender, <22% of L_S), and dark chromatophores forming blotches on body (*v.* body with sparse dark chromatophores not forming blotches).

Centromochlus ferrarisi is only known from a headwater stretch of the Rio das Balsas, a small tributary of the Rio do Sono, itself a tributary of the middle Rio Tocantins basin in the south-eastern Tocantins state, near the watershed divide with the Rio São Francisco and Parnaíba basins (Fig. 8). In that region, the tributaries of the Rio São Francisco basin are on a mostly uneroded versant of a plateau, which is formed mainly by Cretaceous sandstones, whereas the tributaries of the Rio Tocantins basin drain an eroded versant of the same plateau, that is slightly lower than its counterpart (Villela & Nogueira, 2011). In the area, the headwaters of the Rio Sapão (tributary of Rio São Francisco) and the Rio Galheiros (tributary of the Rio Tocantins) are connected, allowing limited faunistic interchange (Lima & Caires, 2011). On the eastern versant, *C. bockmanni* is recorded from a nearby locality in the Rio Preto, a tributary of Rio Grande, itself a left margin tributary of the Rio São Francisco, in north-western Bahia (Fig. 8). *Centromochlus bockmanni* is undoubtedly the geographically closest congener to *C. ferrarisi*, as the type locality of the latter is situated only 172 km in a straight line from the Rio Preto locality where *C. bockmanni* was collected. Although both species have seven branched anal-fin rays and lack the anterior nuchal plate, they are morphologically quite distinct. The two species differ in several proportional measurements: body depth *c.* 28% of L_S in *C. ferrarisi* (*v.* 25% in *C. bockmanni*), body width *c.* 20% of L_S in *C. ferrarisi* (*v.* 18% in *C. bockmanni*); spines of dorsal and pectoral fins <15%

of L_5 in *C. ferrarisi* (v. 18% in *C. bockmanni*). Furthermore, in *C. ferrarisi*, the third unbranched anal-fin ray is thicker than the preceding ray (v. similar than preceding ray in *C. bockmanni*); the dark chromatophores on the body form blotches (v. dark chromatophores isolated in *C. bockmanni*).

Centromochlus ferrarisi is morphologically more similar to two congeners occurring in more distant areas, *C. meridionalis* and *C. perugiae*. *Centromochlus meridionalis* was recently described from the upper Rio Tapajós basin, whereas *C. perugiae* is known from the upper Rio Paraguay and upper Amazon basins. The three species have complementary distribution patterns, occurring in the upper reaches of neighbouring Amazonian river systems. *Centromochlus ferrarisi* shares two derived features with the two species: the third unbranched ray of the anal fin of mature males is distinctly enlarged (character 34 of Soares-Porto, 1998), and large body depth, c. 25% of L_5 (v. <20%). Moreover, the presence of proximal retrorse serrations and distal antrorse serrations on the anterior face of the pectoral-fin spine, small eyes (<18% of L_H) and a mottled colour pattern on mid-dorsal portions of head and trunk are features observed only in *C. meridionalis* and *C. ferrarisi*. This suggests that those two species are sister taxa.

The putative sister taxa relationship between *C. ferrarisi* and *C. meridionalis* is significant biogeographically, as both species occur in the upper, shield-draining, portions of the Rio Tocantins and Rio Tapajós basins. That distribution fits the 'shield distribution pattern' discussed by Lima & Ribeiro (2011). The absence of a representative of this clade in the intervening Rio Xingu basin may be the result of either a historical extinction event or lack of collection of these cryptic, relatively scarce and possibly geographically restricted small catfishes. The putative sister relationship of *C. perugiae* with the clade formed by *C. ferrarisi* and *C. meridionalis* is also interesting. *Centromochlus perugiae* is a taxon that displays a 'foreland basin distribution pattern', occurring in the Rio Paraguay and upper Amazon basins (Lima & Ribeiro, 2011). Further studies unravelling the diversity and phylogenetic relationships of the Centromochlinae will undoubtedly increase understanding of the biogeographical events that have influenced the current distribution patterns among species of the group.

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