

***Glanidium botocudo*, a new species from the rio Doce and rio Mucuri, Minas Gerais, Brazil (Siluriformes: Auchenipteridae) with comments on taxonomic position of *Glanidium bockmanni* Sarmiento-Soares & Buckup**

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Glanidium botocudo, new species, is described from the tributaries to the upper rio Doce and Mucuri, eastern Minas Gerais State, Brazil. It represents the northernmost record of a centromochlin catfish from the coastal rivers of the Northeastern Atlantic Forest. *Glanidium botocudo* is readily distinguished from its congeners, except *Glanidium albescens*, by the whitish grey body coloration with evenly spaced small dark brown dots. The new species has a long sharpened ventral process on the urohyal, an uncommon condition among congeners, and the lowest vertebral count among the large-sized *Glanidium*, 36-37. It differs from *Glanidium albescens* by proportional measurements and higher number of ribs. *Glanidium botocudo* and *Glanidium albescens* are probably sister species, exhibiting similar morphological features and a complimentary distribution pattern, associated to an allopatric distribution pattern. *Glanidium bockmanni* is transferred to the genus *Centromochlus*.

Glanidium botocudo, espécie nova, é descrita para tributários do alto rio Doce e rio Mucuri, leste de Minas Gerais, Brasil. Representa o registro mais ao norte de um bagre centromoclíneo nos rios do Nordeste da Mata Atlântica. *Glanidium botocudo* é prontamente distinguido de todos seus congêneres, exceto *Glanidium albescens*, pelo colorido cinza-esbranquiçado do corpo com máculas castanho-escuras regularmente espaçadas. A espécie nova apresenta processo ventral do uro-hial longo e afilado, uma condição incomum entre os congêneres, e ainda a menor contagem vertebral entre os *Glanidium* de grande porte, 36-37. Diferencia-se de *Glanidium albescens* por proporções corporais e maior número de costelas. *Glanidium botocudo* e *Glanidium albescens* são possivelmente espécies irmãs, apresentando características morfológicas similares e padrões de distribuição complementar, associados a um padrão de distribuição alopatrica. *Glanidium bockmanni* é transferido para o gênero *Centromochlus*.

Key words: Centromochlinae, *Centromochlus*, Distribution, South America, Systematics.

Introduction

Fishes of the auchenipterid subfamily Centromochlinae are spread throughout cis-Andean South America, and comprise the genera *Centromochlus* Kner, *Tatia* Miranda-Ribeiro, *Glanidium* Lütken, and *Gelanoglanis* Böhlke.

Glanidium contains seven recognized species, ranging from coastal rivers along Suriname to river systems draining the laguna dos Patos system in southern Brazil (Akama & Sarmiento-Soares, 2007; Ferraris, 2007). A single, disjunct, northern species, *Glanidium leopardus* Hoedeman was recorded from river basins in Suriname and French Guiana. Two species inhabit upper and middle portions of rio São Francisco drainage, *Glanidium albescens* Lütken and *Glanidium bockmanni* Sarmiento-Soares & Buckup. Two additional species, *Glanidium ribeiroi* Haseman and *Glanidium cesarpintoi* Ihering, were described from the rio Paraná system, respectively from the rio Iguaçu system and upper

rio Paraná basin. In the Brazilian coastal rivers between southern Espírito Santo and Rio Grande do Sul there are two species, *Glanidium melanopterum* Miranda Ribeiro, described from upper rio Paraíba do Sul, and *Glanidium catharinensis* Miranda Ribeiro, described from a coastal Santa Catarina river basin. These two species are in need of further investigation regarding their identity and limits of distribution.

Glanidium is the sole centromochlin genus with representatives in the rio São Francisco basin and in small riverine basins along the Brazilian coast and is the only genus within the subfamily without representatives in the Amazon and Orinoco river systems. On the other hand, the remaining centromochlin members are mainly distributed in inland drainages, such as the Amazon and Orinoco. *Glanidium* species are found in sympatry with some *Tatia* species in upper portions of rio Paraná drainage. Sympatry among species from distinct centromochlin genera is also observed in other drainages, such as the Amazon.

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In the present paper we describe a new species of *Glanidium* from eastern coastal rivers of the Brazilian Floresta Atlântica. The population at rio Doce and rio Mucuri was referred to *G. albescens* in Sarmiento-Soares & Martins-Pinheiro (2007), but additional comparisons revealed it as a new species. It represents the first report of members of the subfamily in river drainages crossing the coastal tablelands relief of the Barreiras Group.

Material and Methods

Osteological features were examined in cleared and stained (CS) specimens prepared according to the procedures of Taylor & van Dyke (1985). Prior to clearing and staining, specimens were dissected whenever possible to determine gut contents, sexual maturity of gonads, and to record myological information. Osteological data from some species poorly represented in ichthyological collections were obtained from radiographs (indicated as “R” in the Comparative Material section). Nomenclature of osteological elements is based on Fink & Fink (1981), Arratia (2003) and nomenclatural suggestions by Britto (2002) and Birindelli (2010). Most names are explained in The Zebrafish Information Network (ZFIN, 2012). Muscle names follow Sarmiento-Soares & Porto (2006). Drawings were rendered from a camera lucida or from digital photographs preferably of CS specimens. Straight-line measurements were made with a digital caliper, and recorded in tenths of a millimeter.

Measurements included: standard length (SL, from snout tip to caudal-fin base); body depth (on nuchal shield, from origin of dorsal-fin spine to the belly); body width (widest distance between lateral surfaces of cleithra, taken between anterior-most margin of cleithral bone beneath pectoral-fin origin); caudal-peduncle depth (least distance between dorsal and ventral surfaces of caudal peduncle); caudal-peduncle length (from base of posterior-most anal-fin ray to point coinciding with origin of lowermost principal caudal-fin ray); predorsal length (from snout tip to origin of dorsal fin); preanal length (from snout tip to anal-fin origin); prepelvic length (from snout tip to pelvic-fin origin); dorsal-fin origin to pectoral-fin origin; dorsal-fin origin to pelvic-fin origin; pectoral-fin origin to pelvic-fin origin; prepectoral length (from snout tip to pectoral-fin origin); dorsal-fin base (from origin of dorsal-fin spine to posterior-most base of dorsal-fin insertion); adipose-fin base (from origin of adipose fin fold to its posterior-most base); anal-fin base (distance between genital opening and posterior-most base of anal-fin insertion, measured under the same criteria for both males and females); dorsal-fin spine length (from base of spine to its distal tip); pectoral-fin spine length (from origin of spine to its distal tip, taken with the spine erected); postcleithral (humeral) process length (from anterodorsal margin of exposed process to posterior-most tip of process); first branched pelvic-fin ray (from base to tip of first branched pelvic-fin ray); longest anal-fin ray (from base to tip of first branched anal-fin ray); head length (HL, from snout tip to bony end of opercle); head width (between dorsalmost extents of opercular openings); snout depth (distance in median sagittal plane between posterior nostril and midventral contour of body);

interorbital distance (least distance between dorsalmost margins of bony orbit); left internarial width (between left anterior and left posterior nostrils); anterior internarial distance (transverse distance between anterior nostrils); posterior internarial distance (transverse distance between posterior nostrils); snout length (from snout tip to anteriormost margin of eye); maxillary-barbel length (from base to tip, with barbel retracted); outer mental-barbel length (from base to tip, with barbel retracted); inner mental-barbel length (from base to tip, with barbel retracted); eye diameter (greatest horizontal diameter of eyeball); mouth width (between corners of closed mouth).

Counts of fin rays and bony elements were obtained from alcohol-preserved and CS specimens. Vertebral counts included all rib-bearing centra plus five anterior, complex centrum elements without ribs, and included the compound caudal centrum (PU1+U1) as the last element. Counts of branchiostegal rays were done only in cleared and stained specimens.

Institutional abbreviations are as follows: Departamento de Zoologia e Botânica, Universidade Estadual Paulista “Júlio de Mesquita Filho”, câmpus de São José do Rio Preto, São José do Rio Preto (DZSJRP); Departamento de Zoologia, Universidade Federal de Minas Gerais, Belo Horizonte (DZUFMG); Field Museum of Natural History, Chicago (FMNH); Museu de Biologia Professor Mello Leitão, Santa Teresa (MBML); Museu de Ciências e Tecnologia, Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre (MCP); Museu de História Natural Capão da Imbuia, Curitiba (MHNCI); Museu Nacional, Rio de Janeiro (MNRJ); Museu de Zoologia da Universidade de São Paulo, São Paulo (MZUSP); Netherlands Centre for Biodiversity Naturalis (formerly Rijksmuseum van Natuurlijke Historie), Leiden (RMNH. PISC); Núcleo de Pesquisas em Limnologia, Ictiologia e Aquicultura/ Fundação Universidade Estadual de Maringá, Maringá (NUP), National Museum of Natural History, Smithsonian Institution, Washington D.C. (USNM) and Zoologisk Museum, Copenhagen (ZMUC).

Results

Comments on *Glanidium bockmanni*. *Glanidium* is recognized as a monophyletic clade and regarded as the sister group to other centromochlin genera (Soares-Porto, 1998; Birindelli, 2010). We observed that the small-sized *G. bockmanni*, is remarkably distinct from the large-sized *Glanidium* species. *Glanidium* is the only Centromochlin genus with species exhibiting a large number of segments on the third modified unbranched anal-fin ray of adult males (26-43 segments). However, *G. bockmanni* male anal fin bears 13-15 segments on third unbranched anal-fin ray (Sarmiento-Soares & Buckup, 2005). The proximal anal-fin radials becoming enlarged and sutured to each other in mature males is a uniquely derived feature of *Glanidium* (Soares-Porto, 1998: fig. 19). In comparison to the sutured proximal radials in males of other *Glanidium* species, *G. bockmanni* exhibits a partial fusion of proximal radials in the anal fin of modified adult males (illustrated in Sarmiento-Soares & Buckup, 2005: fig. 3). Birindelli (2010: 287) noticed such a fusion and postulated the need of further investigations regarding *Glanidium* monophyly.

Glanidium bockmanni exhibits other features not found in the remaining *Glanidium* species, such as: the absence of the first nuchal plate (*vs.* presence), the thin m. *adductor mandibulae* muscle section A2, associated to a discrete concavity between the sphenotic and the pterotic (*vs.* voluminous A2, associated to deep concavity), and the proportionally larger eye diameter, 20–24% of HL (*vs.* 14–22% of HL). *Glanidium bockmanni* belongs to the clade composed by *Centromochlus*, *Tatia*, and *Gelanoglanis*, given that all its proximal radials are basally fused to each other, forming a single ossification (character 30 - state 2 of Soares-Porto, 1998). *Glanidium bockmanni* is a valid centromochlin species, but should not belong to *Glanidium*. According to the synapomorphies of *Centromochlus* hypothesized by Soares-Porto (1998), *G. bockmanni* bear a maxilla longer than the palatine (character 2 - state 1 of Soares-Porto, 1998: 334) and an elongate ventrolateral process of infraorbital 1 (lacrimal of Soares-Porto, 1998), forming anterior border of orbit (character 14 - state 1 of Soares-Porto, 1998: 338). *Centromochlus* monophyly requires further investigation, but on its present arrangement, *G. bockmanni* presents the derived features postulated for that genus. Therefore, we herein propose the transfer of the species to the genus *Centromochlus*, *i.e.*, *Centromochlus bockmanni*, new combination.

Glanidium botocudo, new species

Fig. 1

Holotype. MNRJ 32538, 93.0 mm SL, Brazil, Minas Gerais State, Nanuque, rio Mucuri, downstream from Santa Clara Dam, approximately 17°53'28"S 40°12'58"W, Nov 1997, P. S. Pompeu & A. L. Godinho.

Paratypes. All from Brazil, Minas Gerais. DZUFMG 47, 1, 95.0 mm SL, collected with the holotype. DZUFMG 48, 1, 83.0 mm SL and MNRJ 32539, 1, CS, 82.0 mm SL, Ponte Nova, rio Doce basin, rio Piranga, on area of influence of Baú I Dam, 20°17'07"S 42°55'13"W, Mar 1998, F. Vieira & P. S. Pompeu. DZUFMG 49, 1, 89.0 mm SL, limit between Dores de Guanhões and Braúnas, rio Doce basin, rio Santo Antônio drainage, rio Guanhões at Salto Grande Reservoir, 19°06'17"S 42°47'13"W, Jan 1999, F. Vieira & P. S. Pompeu. MBML 2047, 2, R, 86.8–95.5 mm SL, Santa Cruz do Escalvado, rio Doce on area of influence of Baú I Dam, 20°15'24"S 42°54'56"W, Mar 1998, F. Vieira & P. S. Pompeu. MNRJ 31460, 2, 83.0–91.0 mm SL, córrego Joanésia, tributary of rio Santo Antônio, Joanésia, near limits with Açucena, downstream from Porto Estrela Reservoir, rio Doce basin, 19°07'48.6"S 42°39'21.2"W, 2–6 Dec 2004, R. E. S. Hojo.



Fig. 1. *Glanidium botocudo*, new species, (a) holotype, MNRJ 32538, male, 93.2 mm SL, rio Mucuri downstream from Santa Clara Dam, Nanuque, Minas Gerais State, Brazil. (b) paratype, MBML 2047, female, 86.8 mm SL, rio Doce, on area of influence of Baú I Dam, Santa Cruz do Escalvado, Minas Gerais State, Brazil.

Diagnosis. *Glanidium botocudo* is distinguished from its congeners, except *G. albescens*, by having small dark spots over a pale yellow ground color (vs. large dark blotches over a pale brown ground color). The new species differs from *G. albescens* by proportions of pectoral fin spine length, about 21-26 % in SL (vs. 17-20% in SL), by rib count 10 (vs. 9) and vertebral count 36-37 (vs. 38-39). *Glanidium botocudo* is distinguished from *G. cesarpintoi*, *G. albescens*, *G. leopardum*, *G. melanopterum*, *G. catharinensis*, and *G. ribeiroi* by having 36 or 37 (n=5) vertebrae (vs. 38 or 39 in *G. cesarpintoi* (n=2), 38 or 39 in *G. albescens* (n=3), 40 or 41 in *G. leopardum* (n=2), 41 in *G. melanopterum* (n=5), 41 in *G. catharinensis* (n=2), and 44 in *G. ribeiroi* (n=2)). The new species is also distinguished by having the anterior margin of the pectoral fin spine with serrae on its entire margin (vs. serrae restricted to distal portion of spine in *G. melanopterum*, *G. catharinensis* and *G. ribeiroi* or smooth anterior margin in *G. leopardum*) and by a long sharpened ventral process on urohyal (vs. distinctly short robust process in *G. melanopterum*, *G. cesarpintoi*, *G. catharinensis*, and *G. ribeiroi*).

Description. Morphometric data in Table 1. Body short, head slightly depressed dorso-ventrally. Head robust, outline of head in dorsal view somewhat elliptic, longer than broad. Trunk from dorsal-fin base to caudal peduncle gradually compressed. Lateral profile of head from snout tip to opercular margin slightly convex until pectoral-fin insertion. Ventral profile of head and abdomen almost straight. Ventral profile of body gently curved, concave behind anal-fin origin. Head integument thick, cranial roof not visible; well-developed adipose eye lid; eye latero-dorsally located in anterior portion of head; mouth terminal, upper lip extended postero-laterally as well-developed fleshy rictal fold; snout margin rounded, in dorsal view; anterior nostril tubular, located on anterior border of snout; posterior nostril somewhat larger, rounded, limited by small skin flap; transverse distance between anterior nostrils proportionally shorter than distance between posterior ones. Maxillary barbel short, extending slightly beyond membranous border of opercle, reaching posterior cleithral process base; mental barbels short, tip not reaching pectoral-fin base, arranged in arc along ventral surface of

Table 1. Morphometric data for *Glanidium botocudo*. SD = standard deviation; N = number of specimens examined.

| | Holotype | Range | Mean | SD | N |
|--|-----------------------------|-----------|------|------|---|
| Standard length (mm) | 93.2 | 82.0-95.5 | 88.6 | | 9 |
| | Percents of standard length | | | | |
| Body depth | 19.6 | 16.5-22.1 | 20.2 | 1.60 | 9 |
| Body width | 20.8 | 20.8-22.5 | 21.8 | 0.63 | 9 |
| Caudal-peduncle depth | 11.4 | 10.4-12.7 | 11.3 | 0.78 | 9 |
| Caudal-peduncle length | 25.5 | 20.4-25.5 | 22.0 | 1.77 | 9 |
| Predorsal length | 32.4 | 32.4-35.6 | 34.5 | 1.08 | 9 |
| Preanal length male | 74.0 | 73.3-76.3 | 74.6 | 1.59 | 4 |
| Preanal length female | - | 68.6-72.1 | 69.3 | 1.55 | 5 |
| Prepelvic length | 54.3 | 52.8-58.4 | 55.5 | 1.62 | 9 |
| Dorsal-fin origin to pectoral-fin origin | 20.9 | 20.9-25.1 | 22.9 | 1.42 | 9 |
| Dorsal-fin origin to pelvic-fin origin | 31.2 | 29.4-34.0 | 31.7 | 1.30 | 9 |
| Pectoral-fin origin to pelvic-fin origin | 36.8 | 32.9-37.4 | 35.6 | 1.72 | 9 |
| Prepectoral length | 22.2 | 22.2-25.7 | 23.7 | 1.56 | 9 |
| Dorsal-fin base length | 10.2 | 7.9-10.9 | 9.4 | 1.12 | 9 |
| Adipose-fin base length | 5.0 | 3.4-5.4 | 4.3 | 0.70 | 9 |
| Anal-fin base length male | 6.7 | 5.7-6.7 | 6.0 | 0.52 | 4 |
| Anal-fin base length female | - | 9.5-11.0 | 10.0 | 0.58 | 5 |
| Dorsal-fin spine length | 13.0 | 13.0-17.2 | 14.9 | 1.78 | 9 |
| Pectoral-fin spine length | - | 20.7-26.0 | 22.9 | 1.69 | 7 |
| Length of posterior process of cleithrum | 13.7 | 13.7-18.9 | 16.6 | 1.47 | 9 |
| Length of first branched pelvic-fin ray | 13.7 | 12.1-14.0 | 12.8 | 0.71 | 9 |
| Longest anal-fin ray of males | 14.8 | 13.9-15.0 | 14.6 | 0.57 | 4 |
| Longest anal-fin ray of females | - | 12.2-13.7 | 12.7 | 0.58 | 5 |
| Maxillary barbel length | 26.6 | 26.2-32.3 | 28.6 | 2.06 | 9 |
| Outer mental barbel length | 8.3 | 7.3-9.3 | 8.3 | 0.61 | 9 |
| Inner mental barbel length | 4.9 | 4.6-6.2 | 5.3 | 0.53 | 9 |
| Head length | 24.0 | 24.0-26.7 | 25.3 | 0.85 | 9 |
| | Percents of head length | | | | |
| Head width | 79.5 | 73.6-79.5 | 75.7 | 1.84 | 9 |
| Head depth | 46.4 | 46.4-51.2 | 48.8 | 1.85 | 9 |
| Interorbital distance | 53.1 | 48.6-53.8 | 51.1 | 1.78 | 9 |
| Left internarial width | 20.5 | 18.6-20.5 | 19.5 | 0.60 | 9 |
| Anterior Internarial distance | 39.3 | 33.6-39.3 | 35.7 | 1.90 | 9 |
| Posterior internarial distance | 40.2 | 35.1-40.2 | 37.3 | 1.98 | 9 |
| Snout length | 38.4 | 33.3-38.4 | 35.5 | 1.95 | 9 |
| Orbital diameter | 17.5 | 17.5-20.2 | 18.7 | 0.89 | 9 |
| Mouth width | 57.6 | 52.2-57.6 | 55.6 | 2.04 | 9 |

jaw; inner mental barbel about 56.2-71.0% length of outer mentals. Posterior process of cleithrum short almost reaching vertical through origin of dorsal fin. Caudal peduncle moderately deep, depth about 10.4-12.7% SL.

Rostral border of cranium with mesethmoid longer than broad (Fig. 2, me); premaxilla underneath with synchondral articulation; elliptical cranial fontanel, with two narrow openings: anterior one between mesethmoid and frontals and posterior one limited to frontals. Fontanel apertures separated from each other by suture beneath frontal, along orbitosphenoid. Nasal ossified, tubular, with narrow medial flanges, not sutured to mesethmoid. Autopalatine as flattened tube, oriented obliquely to longitudinal axis of body. Maxilla about half size of autopalatine. Preopomer developed, with expanded arrow-shaped lateral processes. Jaws of equal size; premaxilla and dentary narrow with four or five rows of robust conical teeth. First nuchal plate irregularly shaped, somewhat ellipsoid (Fig. 2, n1); second nuchal plate slightly concave along lateral margins (Fig. 2, n2); third nuchal plate thin, projected laterally, with prominent tip (Fig. 2, n3). Epioccipital process very small (Fig. 2, pe).

Hyomandibula broad, projected anteriorly (Fig. 3, hy), connected to both quadrate and metapterygoid through cartilage and deep dentate suture. Metapterygoid conical, as wide lamina (Fig. 3, mt), joined to quadrate via dentate suture. Quadrate trapezoidal, with broad base (Fig. 3, qu), connected to preopercle, hyomandibula and metapterygoid; long preopercle (Fig. 3, po) ventral margins sutured to both quadrate and hyomandibula; supraopercle present as short canal bone (Fig. 3, sp); opercle laminate, ornamented and broadly subtriangular (Fig. 3, op).

Hyoid arch with urohyal reduced with long sharpened ventral process (Fig. 4, up); short dorsal hypohyal (Fig. 4, dh) associated with comparatively large ventral hypohyal (Fig. 4, vh); anterior ceratohyal well developed (Fig. 4, ac), posterior ceratohyal smaller (Fig. 4, pc); branchiostegal ray articulated to ceratohyals; branchiostegal rays 6; 4 on anterior ceratohyal, 1 associated with interceratohyal cartilage and posteriormost flattened, associated to posterior ceratohyal.

Branchial (gill) arches with urohyal, anterior to basibranchial 2; basibranchial 2 forming osseous rod, broadest anteriorly; basibranchial 3 shorter; 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. Hypobranchial 1 tubular, and hypobranchial 2 subtriangular, mostly osseous, elongate and expanded laterally, with cartilaginous lateral and medial ends; hypobranchial 3 completely cartilaginous, trapezoidal; hypobranchial 4 absent. Five ceratobranchials, mostly ossified, cartilaginous on both ends. First and second ceratobranchials supporting single row of rakers; third and fourth ceratobranchials with two rows of rakers; fifth ceratobranchial supporting single row of rakers, expanded postero-medially to support lower pharyngeal

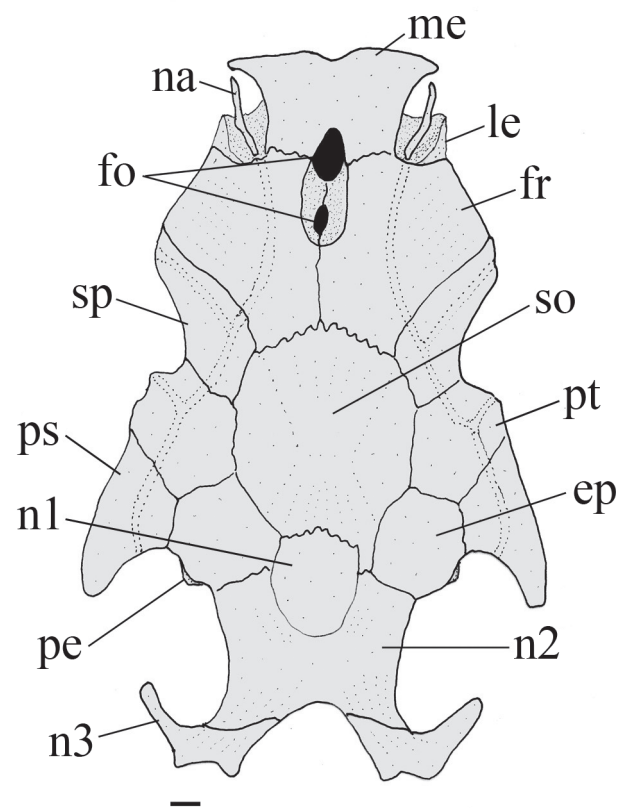


Fig. 2. Neurocranium of *Glanidium botocudo*, MNRJ 32539, paratype, 82.0 mm SL. Dorsal view. Abbreviations: ep, epioccipital; fo, cranial fontanel; fr, frontal; le, lateral ethmoid; me, mesethmoid; na, nasal; n1, first nuchal plate, n2; second nuchal plate; n3, third nuchal plate; pe, posterior epioccipital process; ps, posttemporal-supracleitrum; pt, pterotic; so, supraoccipital; sp, sphenotic. Scale bar = 1.0 mm.

toothplate with short conical teeth. Five epibranchials, all but fifth largely ossified except for cartilaginous ends, supporting one or two rakers each, close to articulation with ceratobranchials. Epibranchials 1 and 2 rod-like; epibranchial 3 with posterior unciniate process; epibranchial 4 with laminar extension; epibranchial 5 cartilaginous, reduced, located on angle between cartilaginous ends of epibranchial 4 and ceratobranchial 4. Pharyngobranchial 1 and 2 absent; accessory cartilage between anteromedial cartilaginous tips of epibranchials 1 and 2; pharyngobranchial 3 elongate, ossified, with expanded posterior border; pharyngobranchial 4 ossified. Upper pharyngeal tooth plate with conical teeth, supported by pharyngobranchial 3 and 4, and also epibranchials 3 and 4.

Infraorbital 1 with ventro-lateral process clearly restricted to anterior border of eye. Subsequent four infraorbitals thin and tubular, in complete infraorbital series. Lateral line on body straight, inconspicuous, with ossified canal bones only anteriorly, unbranched at caudal fin.

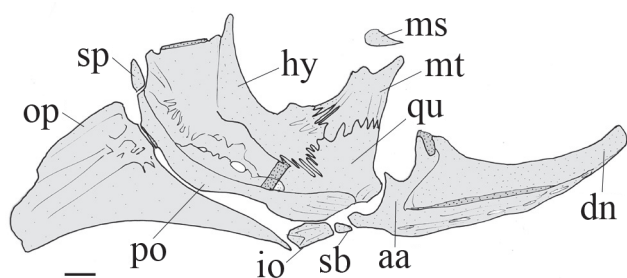


Fig. 3. Right suspensorium of *Glanidium botocudo*, MNRJ 32539, paratype, 82.0 mm SL. Lateral view. Abbreviations: aa, angulo-articular; dn, dentary; hy, hyomandibula; io, interopercle; mt, metapterygoid; ms, mesopterygoid; op, opercle; po, preopercle; qu, quadrate; sb, subpreopercle; sp, suprapreopercle. Scale bar = 1.0 mm.

Dorsal fin II,5, dorsal-fin spine with minute serrations along entire anterior margin, posterior margin with minute serrations on distal tip only. Pectoral fin I,5, pectoral-fin spine with 14-19 antrorse serrations along entire anterior margin; 13-17 retrorse serrations along posterior margin; serrations on anterior margin smaller than posterior. Pelvic-fin i,5, margin rounded. Adipose fin small, origin at vertical through anal-fin base. Anal fin iii,8; anal-fin pterygiophores in nine rod-like proximal radials and eight cartilaginous distal radials. Caudal fin deeply forked, lobes with rounded tips, 8+9 principal rays, 16 upper procurrent, 15 lower procurrent rays.

Ribs 10 attached to consecutive vertebrae, becoming progressively smaller posteriorly. Total vertebrae 36 or 37 ($n = 5$).

Color in alcohol. Dorsal surface of head, body, scattered with small dark-brown chromatophores with depigmented area around adipose fin. Ground color gradually becoming lighter towards ventral parts. Dorsal fin dark brown on its base,

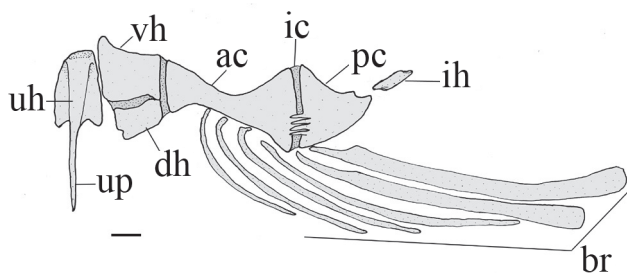


Fig. 4. Right hyoid arch of *Glanidium botocudo*, MNRJ 32539, paratype, 82.0 mm SL. Ventral view. Abbreviations: ac, anterior ceratohyal; br, branchiostegal rays; dh, dorsal hypohyal; ic, interceratohyal cartilage; ih, interhyal; pc, posterior ceratohyal; vh, ventral hypohyal; uh, urohyal; up, urohyal ventral process. Scale bar = 1.0 mm.

becoming pale yellow towards tip. Paired, anal and adipose fins unpigmented. Caudal-fin rays with small dark brown spots.

Sexual dimorphism. Female specimens with a small intumescent genital papilla; with genital and urinary apertures separate. The male genital papilla is formed by a thick skin flap around a short emergent deferent duct. Male anal fin is strongly modified, with a pointed tip formed by the enlarged and thickened third unbranched and first branched rays. First unbranched anal-fin ray proportionally short, relative to subsequent fin-rays (Fig. 5, ui). The second unbranched anal-fin ray of males is elongated and intermediate in size between first and third anal-fin rays (Fig. 5, uii). The third unbranched anal-fin ray of males is about twice the length of first unbranched ray (Fig. 5, uiii). The male third unbranched anal-fin ray has a larger number of segments (26-29) relative to females (17-19). Posterior branched anal-fin rays of males are progressively shorter with last ray being the smallest (Fig. 5, b8).

Distribution. *Glanidium botocudo* was recorded from large coastal river systems, such as the rios Doce and Mucuri (Fig. 6). It is the first record of the genus for the Eastern Atlantic river system (*sensu* CNRH, 2003) and also for Coastal Tablelands of the Barreiras Group. Coastal tablelands correspond to a region of mild relief, with elevations usually not passing 150 m, coinciding with the Cenozoic sediments of the Barreiras Group, well seen along the border between Espírito Santo and southern Bahia. Regarding global biogeographic regionalization of freshwater systems, the new species distribution pattern belongs to Northeastern Mata Atlantica ecoregion (*sensu* Abell *et al.*, 2008).

Ecological notes. *Glanidium* species are nocturnal catfishes that inhabit lotic sections of rivers, and also lakes, in segments with riparian vegetation (F. Vieira, pers. comm.). *Glanidium botocudo* feeds on allochthonous resources, as beetles, and autochthonous aquatic invertebrates, such as insect larvae and gastropods, as evidenced by the examination of gut contents (MNRJ 32539, 82.0 mm SL).

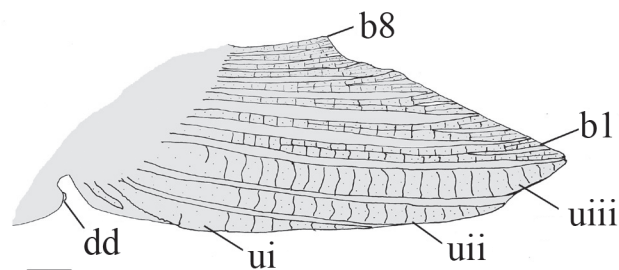


Fig. 5. Male modified anal fin of *Glanidium botocudo*, MNRJ 32539, paratype, 82.0 mm SL. Left side lateral view. Abbreviations: b1, branched first ray; b8, branched eighth ray; dd, deferent duct; ui, unbranched first ray; uii, unbranched second ray; uiii, unbranched third ray. Scale bar = 1.0 mm.

Etymology. The specific name is a reference to the Botocudo, the generic name given to native indigenous people wearing artifacts (“botoques”) on ears and lips. Those Indians were the original inhabitants of large extensions of the Floresta Atlântica (Paraiso, 1992), including the lands along the rio Mucuri valley and far west, to the rio Doce, range of the new *Glanidium* species. A noun in apposition.

Discussion

Glanidium is the sister genus to remaining genera of the Centromochlinae, and retains a plesiomorphic arrangement of anal-fin rays in mature males (Soares-Porto, 1998). Although the phylogenetic position of *Glanidium* is well established, the monophyly of the genus deserves further investigation (see Comments on *Centromochlus bockmanni*).

One distinguishing feature of *G. botocudo* is the long sharpened ventral process on urohyal, projecting beyond the

hypohyals, a condition not yet observed in other congeners. In centromochlin catfishes, such as *Tatia*, the urohyal is usually narrow with a sharp ventral process limited between hypohyals (Sarmiento-Soares & Martins-Pinheiro, 2008: fig. 4). Ferraris (1988), Walsh (1990), and Birindelli (2010) referred to a distinctively long laminar projection of urohyal in *Tetranematichthys* and *Ageneiosus* species. Such a condition in a single *Glanidium* species deserves further comparative investigation.

In its present arrangement, the *Glanidium* species are distributed in inland drainages, such as the upper portions of rio Paraná basin and also in coastal rivers systems, from the Surinam to Rio Grande do Sul, in southern Brazil. Together with *G. melanopterus* and *G. catharinensis*, *G. botocudo* occurs in the coastal rivers of the Brazilian Floresta Atlântica. The range of *G. botocudo* represents the northernmost record of the genus in the biome Floresta Atlântica.

The geographically closest congeners to *G. botocudo* are *G. albescens* and *G. melanopterus*. *Glanidium melanopterus* was recently recorded from coastal rivers of Espírito Santo, such as the rivers Santa Maria da Vitória, Benevente, and Itapemirim. That area corresponds to Northeastern Mata Atlântica freshwater ecoregion (*sensu* Abell *et al.*, 2008) with records of both *G. melanopterus* and *G. botocudo*. A comparison between *G. botocudo* and *G. melanopterus* revealed differences, regarding general body coloration, pectoral-fin spine denticulation, proportional measurements and vertebral count.

On the other hand, *G. albescens*, from upper rio São Francisco and the new *G. botocudo*, from Floresta Atlântica river drainages of rio Doce and rio Mucuri, share a similar color pattern. Although inhabiting distinct freshwater ecoregions, São Francisco and Northeastern Mata Atlântica respectively, these two forms were first recognized as a single species. Both were named as “Pacu branco”, because of the whitish grey body coloration (Sarmiento-Soares & Martins-Pinheiro, 2007). *Glanidium albescens* and *G. botocudo* are probably sister species, exhibiting similar morphological features and a complimentary distribution pattern, associated to an allopatric distribution pattern.

The geographic range of most freshwater species is tightly linked to the course of ancient and modern river ways and watersheds (Lundberg *et al.*, 2000). Tectonic deformations and erosive action over long time frames are expected to have subdivided and isolated fish populations, resulting in speciation, adaptation, extinction or even dispersion (Albert & Reis, 2011). Climatic fluctuations during Quaternary are mentioned as an explanatory model regarding wide range distribution between freshwater species along Brazilian coastal rivers (*e.g.*, Weitzman *et al.*, 1988; Ribeiro *et al.*, 2006; Buckup, 2011). According to this model, continental platform was exposed during several marine regressive events when the sea level was lower and rivers extended onto the continental margin. A hypothesis of stream-capture event and subsequent dispersal to explain distributional patterns in the eastern margin of the Atlantic border of the Brazilian Shield is suggested by Ribeiro (2007), exemplified by *Oligosarcus acutirostris* Menezes, a characid species ranging between the rio Itapemirim, in southern Espírito Santo, to extreme southern

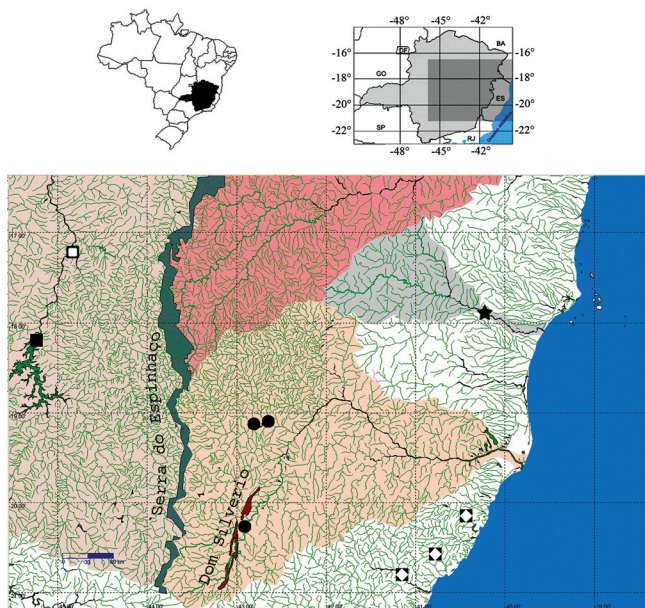


Fig. 6. Map of eastern Brazilian drainages at northeastern Minas Gerais State illustrating regional uplifts: the Serra do Espinhaço (colored in dark gray) and Dom Silvério Group (colored in brown). Contour of river basins in the area as stated: rio São Francisco (in pink), rio Jequitinhonha (in rose), rio Mucuri (in light gray), rio Doce (in salmon). Collecting localities of *Glanidium botocudo* illustrated as black circles. Star indicates type locality. Regional centromochlin species at rio São Francisco basin are illustrated by squares (white - *Glanidium albescens*; black - *Centromochlus bockmanni*). Congener at southern coastal rivers of Espírito Santo, *Glanidium melanopterus*, is illustrated by white lozenges. Symbols may represent more than one locality. Limits of Serra do Espinhaço are based on Valadão (2009) and Dom Silvério Group based on Peres *et al.* (2004).

Bahia drainages. In *Glanidium* a species disjunction is observed in the same area: *G. melanopterum* northern records correspond to the rio Santa Maria da Vitória, on southern Espírito Santo, while *G. botocudo* inhabits the rio Doce and extreme southern Bahia rivers. A possible explanation for *G. melanopterum* distribution pattern through coastal river drainages until southern Espírito Santo could be active dispersal. It is possible that south-north or northeast-southwest fault lineaments were utilized by evolving large rivers during Quaternary. Such a communication between watersheds may represent a pervasive cause of fish dispersal along the southeastern Atlantic rivers (cf. Ribeiro, 2007; Backup, 2011). This faunal dispersal could explain the distribution patterns of *G. melanopterum*, and also of some coastal freshwater fishes, such as *Microglanis parahybae* (Steindachner); *Gymnotus pantherinus* (Steindachner) and *Australoheros muriei* Ottoni & Costa, in which northern range include Espírito Santo, south of the rio Doce.

Regarding *Glanidium albescens* and *G. botocudo* distributional patterns, the evolution of large ancient watersheds may have contributed to vicariant events. The Araçuaí Belt, first portrayed by Almeida (1977), developed along the southeastern margin of the São Francisco Craton, is one of the oldest events to influence the relief before the western-Gondwana break-up (Campos-Neto & Figueiredo, 1995; Alkmim *et al.*, 2007). The driven forces for the closure of an inland sea, the Adamastor Ocean, are probably triggered by collisions along the margins of the São Francisco-Congo plate involving several orogenic steps during Cambro-Ordovician limit (Potter, 1997; Alkmim *et al.*, 2007). The tectonic evolution of the southern Araçuaí belt, at southern Serra do Espinhaço, exhibited additional deformation phases during the Paleoproterozoic (Peres *et al.*, 2004). One of these uplifts, the Dom Silvério Group, molded the hydrographic basins, by abrupt inflection of upper rio Doce channel (Fig. 6; Peres *et al.*, 2004; Valadão, 2009: fig. 12). The final phase reflects the collapse of the Araçuaí-West Congo orogeny, with estimated ages around 509–480 Ma (Peres *et al.*, 2004). A great escarpment, the Serra do Espinhaço (Fig. 6), emerged as a reference to the orogeny, separating the inland area, the São Francisco, from the coastal Atlantic basins, such as Paraguaçu, Contas, Pardo, Jequitinhonha, Mucuri, and Doce river drainages (Valadão, 2009). This scenario is of importance to the understanding of distributional patterns of freshwater fishes, as in Aptian, during Cretaceous fragmentation, these hydrographic coastal basins articulated to the incipient Atlantic Ocean. Many fish lineages originated by that time, including the Ostariophysa (Lundberg, 1993; Albert & Reis, 2011).

The Serra do Espinhaço is nowadays an important watershed divide, between the São Francisco and coastal river drainages. Apparently, the Serra do Espinhaço represents an important geographical barrier to freshwater fish, as many components of the aquatic fauna are distinct between inland and coastal watersheds, as pointed out by Sarmiento-Soares *et al.* (2008; 2009). Divergent allopatric speciation may be the case, between *G. albescens*, from inland São Francisco, and *G. botocudo*, from coastal rivers Doce and Mucuri. The allopatric pattern of geographic distributions between these

two species fits into a model of long-term isolation between coastal Atlantic and São Francisco drainages.

Cenozoic geological events influenced many elements of the Neotropical biota (Albert & Reis, 2011), and may explain the distributional patterns of *Glanidium botocudo*. The break-up of the Gondwana and opening of the South Atlantic Ocean has increased rates of continental denudation. In the case of inland São Francisco drainage, denudation rates were reduced, and waters passed to flow isolated, incised in a tectonic depression, by middle-upper Cretaceous (Potter, 1997; Valadão, 2009). On the other hand, the drainage basins facing the Atlantic Ocean, such as the rivers Doce, Mucuri and Jequitinhonha, experienced episodes of accelerated erosional relief processes during Meso-Cenozoic (Valadão, 2009). These denudation rates continued during Cenozoic and clearly influenced the northeastern Minas Gerais relief, at eastern flank of the Serra do Espinhaço (Ferraz *et al.*, 2010). The dissected relief resulted in deep incisions in the river drainage network, coincident with the area where *G. botocudo* occurs. Anomalies observed in watershed divides between Mucuri, Doce and Jequitinhonha headwaters suggest denudation by aggressive water flow, with subsequent communication between rivers Doce and Mucuri (Ferraz *et al.*, 2010). These elaborations drew out until Mio-Pliocene, when subsequent uplifts locked the river drainage communication. During post-Pliocene the large river valleys delineated, as Doce, Mucuri and Jequitinhonha as observed nowadays. The distribution pattern of *G. botocudo* may be explained by dispersal event during long time communication between Doce and Mucuri valleys until the Pliocene. Other non-closely related Ostariophysan species have distributional congruence with *Glanidium botocudo*, with records in both rio Doce and rio Mucuri: *Pogonopoma wertheimeri* (Steindachner) (Quevedo & Reis, 2002) and *Henochilus wheatlandii* Garman (Castro *et al.*, 2004), hypothesizing dispersal events between rio Doce and rio Mucuri headwaters during the Cenozoic.

This is not the only way to explain disjunct distributional patterns among inland São Francisco and coastal rivers at northern Espírito Santo to southern Bahia. Watershed capture from São Francisco to rio Doce and subsequent dispersal to rio Mucuri, could give an alternative hypothesis, but it is not clear which processes may be involved in such a stream-capture event. The complex history of eastern Atlantic rivers and its inhabitants is a challenge in understanding the cladogenetic events that took place in the area during a long time.

Comparative Material. *Centromochlus bockmanni*. **Brazil.** Rio São Francisco basin. Bahia State. MZUSP 82351, 8, 1 CS, 29.4–35.8 mm SL, rio Preto, Formosa do Rio Preto. Minas Gerais State. MNRJ 25798, 1, 27.5 mm SL, rio Jequitaiá at Jequitaiá, close to Francisco Dumont. MZUSP 82803, 1 R, 48.0 mm SL, holotype; MZUSP 36976, 1 R, 37.2 mm SL, paratype and MZUSP 82804, 1 CS, 41.4 mm SL, paratype, rio São Francisco, downstream from Três Marias Dam. *Glanidium albescens*. **Brazil.** Rio São Francisco basin. Minas Gerais State. MNRJ 16262, 4, 107.5–121.5 mm SL, rio Paraopeba, ZMUC 335, 1 R, 101.0 mm SL, syntype; ZMUC 336, 1 R, 94.0 mm SL, syntype; and ZMUC 337, 1 R, 93.0 mm SL, syntype, rio das Velhas. *Glanidium catharinensis*. **Brazil.** Paraná

State. Rio Guaraqueçaba basin. MHNCI 6569, 2 107.2-158.0 mm SL, rio Morato. Santa Catarina State. Rio Tubarão basin. MCP 25588, 3, 116.5-138.3 mm SL, rio Capivari, tributary of rio Tubarão, Tubarão. MNRJ 5169, 1 R, 89 mm SL, holotype, rio Braço Norte, São Ludgero, Tubarão. São Paulo State. Rio Ribeira de Iguape basin. MZUSP 9308, 1 CS, rio Ribeira de Iguape, Iporanga. *Glanidium cesarpintoi*. **Brazil**. Rio Paranaíba basin. Goiás State, MNRJ uncatalogued, 3, 1 CS, 65.2-83.2 mm SL, and NUP 5699, 7, 77.7-87.9 mm SL, rio Corumbá (Areia), tributary of rio Paranaíba, Pires do Rio near boundary with Ipameri. Rio Tietê basin. São Paulo State. DZSJRP 4570, 1 R, 89.7 mm SL, Salto Grande Reservoir, downstream. DZSJRP 6343, 1, 13.6 mm SL, rio Borá, between Nova Aliança and Potirendaba. *Glanidium leopardum*. **Suriname**. Marowijne rivier basin. RMNH. PISC 28573, 2, 1 R, 56.0 and 71.0 mm SL; and RMNH. PISC 28576, 3, 1 CS, 37.5-71.2 mm SL, Balaté rivier. *Glanidium melanopterum*. **Brazil**. Espírito Santo State. MBML 2118, 2 R, 125.2-144.6 mm SL, rio Santa Maria da Vitória in Mangarai, Santa Leopoldina, Rio Santa Maria da Vitória basin. MBML 2566, 2, 136.8-154.0 mm SL, and MBML 2571, 1, 153.8 mm SL, rio Benevente downstream Alfredo Chaves, Rio Benevente basin. MBML 3913, 1, 131.9 mm SL, rio Itapemirim downstream from ribeirão Itaóca, Rio Itapemirim basin. Rio de Janeiro State. Rio São João basin. MNRJ 12137, 2 R, 107.0-134.5 mm SL, lagoa de Juturnaíba, between Araruama and Silva Jardim. Rio Paraíba do Sul basin. MNRJ 12359, 1 CS, rio Paraíba do Sul, Três Rios. MNRJ 17485, 2, 129.0-190.0 mm SL, ribeirão das Lajes. USNM 41506, 1, 98.6 mm SL, rio Paraíba. *Glanidium ribeiroi*. **Brazil**. Paraná State. Rio Iguacu basin. FMNH 54243, 1. 134.4 mm SL, holotype, Porto União da Vitória. MZUSP 45044, 4 (1 R, 1 CS), rio Iguacu upstream Salto Santiago Dam, Laranjeiras do Sul. NUP 5698, 4, 172.0-193.0 mm SL, rio Iguacu, downstream Caxias Reservoir, Capitão Leônidas Marques.

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