Mastiglanis durantoni from French Guyana, a second species in the genus (Siluriformes: Heptapteridae), with a CT scan survey of phylogenetically-relevant characters

by

Mário DE PINNA^{*} (1) & Philippe KEITH (2)



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Neotropical Taxonomy Systematics Metaspecies Heptapteridae Abstract. - A new species of the heptapterid genus Mastiglanis, M. durantoni, is described from three adjacent localities in the upper reaches of the Maroni River in French Guyana. The new species is distinguished from the only other known species in the genus, M. asopos, by several qualitative and quantitative characteristics, such as the slender caudal peduncle (caudal peduncle depth 4.3-5.3% of SL vs. 5.6-6.3%); the upper jaw protruding markedly beyond lower, resulting in long snout (36.5-42.0% of HL vs. 23.4-33.6%); the head depressed (head depth 34.0-44.4% of HL vs. 44.4-53.0%); the procurrent caudal fin rays 12 dorsally and ventrally (vs. 14-17); the dorsal margin of adipose fin concave (vs. variably convex, straight or gently sinusoidal); the occipital process deeply notched, distally V-shaped (vs. distal margin of occipital process variably-shaped, with notch, when present, not deep and forming an obtuse angle); the mesethmoid cornu widest at its midlength (vs. gradually narrower from base to tip). Characters of taxonomic and phylogenetic relevance are observed and illustrated with CT-scan imaging technique. The narrowly endemic and outlying geographical distribution of the new species contrasts with the extremely wide range of *M. asopos* and suggests a history of peripheral isolation and differentiation. In conformity with that interpretation, the new species has some autapomorphic specializations, while none is currently known for M. asopos.

Résumé. – Mastiglanis durantoni (Siluriformes : Heptapteridae) de la Guyane française, deuxième espèce du genre, avec une étude CT-scan de caractères phylogénétiquement pertinents.

Mastiglanis durantoni est une nouvelle espèce d'Heptapteridae. Elle est décrite dans trois localités adjacentes de la partie supérieure du fleuve Maroni en Guyane française. La nouvelle espèce se distingue de la seule autre espèce connue du genre (*M. asopos*) par plusieurs caractéristiques qualitatives et quantitatives dont le mince pédoncule caudal (hauteur de 4,3% à 5,3% SL vs. 5,6% à 6,3%); la mâchoire supérieure faisant franchement saillie et entraînant un long museau (36,5% à 42,0% HL vs. 23,4% à 33,6%); la tête plus déprimée (hauteur de la tête de 34,0 à 44,4% HL vs. 44,4 à 53,0%) ; caudale avec 12 rayons marginaux ventraux et dorsaux (vs. 14 et 17) ; la marge dorsale de la nageoire adipeuse concave (vs. variable : convexe, étroite ou légèrement sinusoïdale); le processus occipital avec une profonde entaille distale en forme de V (vs. peu ou pas d'entaille); le cornu du mesethmoïde avec la plus grande largeur à mi-longueur (vs. progressivement plus étroit de la base à la pointe). Les caractères à valeur taxonomique et phylogénétique sont observés et illustrés par la technique d'imagerie CT scan. La répartition géographique endémique restreinte et isolée de la nouvelle espèce contraste avec la très large distribution de *M. asopos*. Cela suggère une histoire d'isolement périphérique et de différenciation. Conformément à cette interprétation, la nouvelle espèce présente quelques spécialisations autapomorphiques, alors qu'aucune n'est actuellement connue chez M. asopos.

INTRODUCTION

The genus *Mastiglanis*, so far with a single species M. asopos Bockmann, 1994, belongs to the series of interesting discoveries in heptapterid biodiversity in the past three decades. The small semi-translucent fish inhabits sandy environments in rivers and streams throughout a vast expanse of the Amazon and Orinoco river systems. With its long filamentous pectoral and dorsal fins, it rests on the surface of the substrate facing the current and preys upon passing allocthonous and aquatic invertebrates in midwater or on the bottom (Zuanon et al., 2006). Mastiglanis asopos can dig into the sand with great ease, hiding its entire body almost instantly, sometimes leaving its large eyes exposed on the surface. Since its description, *M. asopos* has remained the only species in its genus. The intervening years have seen a significant expansion of its known geographical distribution, with all such new records putatively representing the same taxon. Indeed, samples of M. asopos from widely disjunct localities throughout the Amazon, Orinoco and other basins display great uniformity of morphological and pigmentation traits. When differences exist, they are often bridged by intervening populations showing intermediate character conditions. Thus, although there may be cases of specific

⁽¹⁾ Museu de Zoologia da Universidade de São Paulo, Av. Nazaré 481, São Paulo-SP 04263-000, Brazil. [pinna@ib.usp.br]

⁽²⁾ Muséum national d'Histoire naturelle, UMR 7208 (MNHN-CNRS-UPMC-IRD), CP 026, 57 rue Cuvier,

⁷⁵²³¹ Paris CEDEX 05, France. [philippe.keith@mnhn.fr]

Corresponding author

differentiation within *M. asopos* as currently delimited, such diversity is not obvious. One exception is a form from the Upper Maroni River in French Guiana, previously referred by Le Bail *et al.* (2012) as *Mastiglanis* aff. *asopos*, which is the subject of this paper. Close examination of that form reveals a number of significant qualitative and quantitative phenotypic differences relative to samples of *M. asopos* from throughout its geographical range. Comparisons show that such character differences are indicative of taxonomically-relevant differentiation and demonstrate that the form from French Guiana is a separate species from *M. asopos*. The purpose of this paper is to diagnose and describe the new species.

especially in view of the wide distribution and phenotypic variability of *M. asopos*. Institutional abbreviations follow Sabaj Pérez (1914). Number of specimens (ex) is provided after the catalogue number, with specimens cleared and stained for bone (B) or bone and cartilage (BC) or radio-graphed (XR) indicated in parentheses as a subset of the total number (when not the entire lot).

Comparative material examined of *Mastiglanis asopos*: **Brazil**: LIRP 7416, 3 ex, Roraima, Município de Mucajaí, Rio Mucajaí (Rio Branco drainage); LIRP 7417, 72 ex (16 XR), Roraima, Boa Vista, Igarapé Au-Au (trib. to Rio Cauamá, Rio Branco drainage); LIRP 7418, 24 ex, Roraima, Município de Boa Vista, R. Cauamé; LIRP 10370, 4 ex (4 XR), Rondonia, Município de Machadinho

MATERIAL AND METHODS

Morphometric values were point-to-point, taken with digital calipers to the nearest 0.1 mm on the left side of specimens whenever possible. Data are expressed as proportions of SL or of HL (for subunits of the head), as indicated in table I. The number of specimens with each meristic value is indicated in parentheses, with those of the holotype marked with an asterisk. Names and definitions of measurements follow Bockmann (1994). The majority of specimens of Mastiglanis examined for osteology were prepared for this study, and cleared and counterstained for bone and cartilage according to a modified version of the method of Taylor and Van Dyke (1985). A few of the specimens were cleared and stained long before the making of this paper and were stained for bone only. Computerized tomography imaging of one paratype of M. durantoni was done in the CT-scan lab at MZUSP (Phoenix vltomelx m, General Electric Co.) using voxel size X = 0.01230097microns, number of images 2500, voltage 80 Kv, and current 280 mA. Image editing used software CTVox (ver. 3.3.0 r1403 64-bit), Data Viewer (ver. 1.5.2 64-bit) and VGStudio MAX (ver. 2.2.3.69611 64-Bit). Vertebral counts include five elements in the Weberian complex and the compound caudal centrum (PU1+U1) is counted as one. Principal caudal-fin ray counts are expressed according to Lundberg and Baskin (1969).

Material examined of *Mastiglanis* species covers most of the geographical range of the genus and includes 52 cleared and stained specimens (plus 23 radiographed), including type material of *M. asopos*, this being the largest collection of osteological specimens of the genus yet assembled. Such extensive skeletal sampling was needed because several of the diagnostic features of the new species are osteological and it was necessary to consistently discriminate intraspecific variation from taxonomically-relevant differentiation,

Table I. – Morphometric values of *Mastiglanis durantoni*. Data are expressed as proportions of SL or of HL (starting with head depth).

	Holotype	Average	Range
Standard length (mm)	63.7	55.99	44.9-68.3
Predorsal length	0.35	0.352	34.4-36.3
Preanal length	0.69	0.694	68.2-70.9
Prepelvic length	0.43	0.422	41.4-43.0
Preadipose length	0.65	0.663	65.0-67.1
Caudal peduncle length	0.24	0.226	21.1-24.0
Caudal peduncle depth	0.05	0.047	4.3-5.3
Adipose fin length	0.22	0.212	19.7-22.8
Dorsal fin to adipose fin	0.2	0.199	18.5-21.2
Anal fin base	0.09	0.097	8.9-11.4
Dorsal fin spine length	0.39	0.4	39.0-41.4
Length of 1st branched dorsal fin ray	0.21	0.236	21.0-25.8
Length of 2 nd branched dorsal fin ray	0.18	0.191	17.5-20.9
Dorsal fin base	0.12	0.115	10.0-12.4
Pelvic fin length	0.16	0.171	16.0-18.4
Pectoral fin spine length	0.54	0.511	38.1-60.1
Length of 1st branched pectoral fin ray	0.17	0.187	17.0-20.3
Length of 2^{nd} branched pectoral fin ray	0.16	0.151	14.0-16.8
Body depth	0.1	0.113	10.0-12.8
Body width	0.15	0.155	14.2-17.1
Maxillary barbel length	0.72	0.676	56.2-77.8
Outer mental barbel length	-	0.385	26.0-43.2
Inner mental barbel length	-	0.183	14.9-29.6
Head length	0.23	0.237	23.0-24.6
Head depth	0.34	0.405	34.0-44.4
Head Width	0.64	0.641	57.5-74.1
Bony interorbital	0.08	0.095	8.0-10.6
Fleshy interorbital	0.12	0.143	12.0-16.5
Eye diameter	0.23	0.232	21.0-25.2
Preorbital length	0.38	0.388	36.5-40.9
Snout length	0.4	0.398	36.5-42.0
Internarial length	0.16	0.18	16.0-22.1
Anterior internarial width	0.14	0.141	12.1-15.7
Posterior internarial width	0.1	0.101	8.8-11.2

d'Oeste, Igarapé Preto (Rio Madeira drainage); LIRP 11735, 8 ex, Rondônia, Município de Machadinho d'Oeste, R. Machadinho (trib. to Rio Machado, Rio Madeira drainage); LIRP 11889, 7 ex. Rondonia, Município de Machadinho d'Oeste, Igarapé Preto (Rio Madeira drainage); MZUSP 22795, 2 ex, Maranhão, Igarpé Gurupi-Una, 45 km from Canindé; MZUSP 30617, 84 ex (6BC), paratypes, Amazonas, Barcelos, Rio Negro; MZUSP 44215, 1 ex c&s, Amazonas, Rio Daraá, Cachoeira do Aracu MZUSP 48973, 3 ex, Rondônia, Rio Machado (Rio Madeira drainage): MZUSP 56860, 16 ex, Amazonas, Rio Solimões; MZUSP 81411, 35 ex (3BC), Amazonas, Rio tiquié (Rio Negro drainage); MZUSP 86240, 61 ex (5BC), Mato Grosso, Rio Cristalino (Rio Araguaia drainage); MZUSP 86262, 202 ex (15BC), Mato Grosso, Corixão do Meio (Rio Araguaia drainage); MZUSP 86958, 52 ex (4BC), Amazonas, Igarapé Sucuriju (Rio Preto da Eva drainage); MZUSP 87087, 9 ex, Mato Grosso, Rio Jatobá (Rio Xingu drainage); MZUSP 88972, 3 ex, Amazonas, Rio Preto da Eva; MZUSP 89330, 29 ex, Goiás, Córrego Pitomba (trib. to Rio Crixás-Mirim; Rio Araguaia drainage); MZUSP 93307, 29 ex (3BC), Amazonas, Igarapé Cunuri (Rio Negro drainage); MZUSP 97150, 100 ex (10BC), Pará, Rio Curuá (Rio Xingu drainage); MZUSP 109497, 5 ex, Amazonas, Rio Negro at Santa Isabel do Rio Negro; MZUSP 115241, 2 ex, Roraima, Rio Uraricoera (Rio Branco drainage); MZUSP 116837, 12 ex (2BC), Pará, Rio Cururu (Rio Tapajós drainage); UFRJ 382, 1 ex c&s, paratype, Pará, Castanhal, Rio Capim basin. Guyana: USNM 403853, 1 ex, Cuyuni River, beach immediately downstream from rapids at Kanaima Falls; USNM 377573, 6 ex, sand bank opposite Mour. Venezuela: MNHN 2015-250, Caño north of Puerto Ayacucho, Río Orinoco; MNHN 2015-251, 1B, Caño north of Puerto Ayacucho, Río Orinoco, Venezuela; MZUSP 45885, 5 ex (1BC), Bolivar, Río Orocopiche; USNM 270037, 6 ex, 19.6-39.1 mm SL, Venezuela, Amazonas, Ature, caño ca. 15 km south of El Burro, on road from Puerto Ayacucho to El Burro (06°02'N, 67°23'W).

Mastiglanis durantoni, new species (Figs 1-2)

Megalonema cf. *platycephalum*; Le Bail *et al.*, 2000: 95. *Mastiglanis aff. asopos*; Le Bail *et al.*, 2012: 304, 316.

Holotype. – MNHN 2015-244, 63.7 mm SL, Tampok River, tributary to Maroni stream, French Guiana, coll. P. Keith, P.Y. Le Bail, 17 Nov. 1998.

Paratypes. – MNHN 2015-245, 3 ex, 43.9-64.9 mm SL, same data as holotype; MNHN 2015-0248, 2B, 54.7-70.7 mm SL, same data as holotype. MZUSP 118118, 2 ex, 46.9-67.1 mm SL, same data as holotype; MNHN 2015-246, 2 ex, 46.3-50.6 mm SL, Grand Inini, tributary to Maroni stream, French Guiana, coll. P.Y. Le Bail, P. Keith, M. Jégu, E. Vigneux, M. Duranton, 30 Sep. 1997; MZUSP 118119, 2 ex (1BC), 41.2-44.9 mm SL, same data as MNHN 2015-246.



Figure 1. – *Mastiglanis duranton*i, n. sp., holotype, MNHN 2015-244, male, 63.7 mm SL, Tampok River, tributary to Maroni stream, French Guiana. Lateral view.



Figure 2. – *Mastiglanis durantoni*, n. sp., holotype, MNHN 2015-244, 63.7 mm SL. (A) Dorsal and (B) ventral views of head.

Diagnosis

Distinguished from its only congener, *M. asopos*, by the following characteristics: 1) slender caudal peduncle (Fig. 1; caudal peduncle depth 4.3-5.3% of SL vs. 5.6-6.3%); 2) upper jaw protruding markedly beyond lower, resulting in long snout (Fig. 3; 36.5-42.0% of HL vs. 23.4-33.6%); 3) head depressed (Fig. 1; head depth 34.0-44.4% of HL vs. 44.4-53.0%); 4) procurrent caudal fin rays 12 dorsally and ventrally (vs. 14-17); 5) dorsal margin of adipose fin concave (vs. variably convex, straight or gently sinusoidal); 6) occipital process deeply notched, distally V-shaped, forming an acute angle (Fig. 4; vs. distal margin of occipital process variably-shaped, with distal concavity, when present, semicircular or not deep, forming an obtuse angle); 7) mesethmoid cornu widest at its midlength (Fig. 5; vs. gradually narrower from base to tip).



Figure 3. – Heads in ventral view, showing difference in upper-jaw lengths. A: Mastiglanis durantoni, n. sp., paratype, MZUSP 118118, 46.9 mm SL; B: Mastiglanis asopos, paratype, MZUSP 7446, 43.9 mm SL.



Figure 4. – CT scan image of supraoccipital of *Mastiglanis durantoni*, MZUSP 118118, paratype. A: Dorsal view: **B**: Ventral view. Anterior to top.

Description

Morphometric data provided in table I. Refer to figures 1 and 2 for general aspect. Dorsal profile of body sloping from tip of snout to orbit, less so from that point to dorsalfin origin, nearly straight from that point to adipose-fin origin and then slightly concave towards caudal fin. Ventral profile straight to anal-fin origin, gently concave along caudal peduncle. Body elongated, slightly depressed at dorsal-fin origin, gradually more compressed toward caudal peduncle. Concentration of adipose bodies on axillary region, immediately dorsoposteriorly to base of pectoral fin, composed of globular corpuscles, opaque-white in preserved specimens. Lateral line complete, extending posteriorly to basal third to half of caudal fin, between upper and lower lobes. Myomeres visible through skin along most of body. Head depressed, dorsally covered by thin skin. Cheeks formed by muscular mass of

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adductor mandibulae, dorsally forming well-defined groove accommodating basal portion of maxillary barbel. Snout long and strongly depressed, semicircular in dorsal view. Posterior nostrils well separated from anterior nostrils (internarial length about twice posterior internarial width), partially occluded with flexible anterior skin flaps. Eyes large, closely positioned in dorsal view, with orbital rim subtly invaginated anteroventrally. Mouth inferior, crescent-shaped, with flat fleshy rictal fold. Upper jaw markedly longer than lower, with premaxilla extending considerably anteriorly to mandibular symphysis (Fig. 3A), forming nearly spatulate snout (Figs 2, 3A). Premaxilla (Fig. 6) with approximately 40 tiny viliform teeth arranged in 3-4 irregular rows, its posterior comer gently curved posteriorly. Lower jaw delicate, with anguloarticular widely trabeculate on lateral surface, with similar dentition disposed in 2-3 rows (Fig. 7). Vomer edentulous (Figs 5,



Figure 5. – CT scan image of anterior portion of neurocranium of *Mastiglanis durantoni*, MZUSP 118118, paratype, dorsal view. Abbreviations: fr, frontal; le, lateral ethmoid; me, mesethmoid.



Figure 6. – CT scan image of premaxilla of *Mastiglanis durantoni*, MZUSP 118118, paratype. A: Dorsal view; B: Ventral view. Anterior to top.

8). Barbels nearly ovoid or round in cross section. Maxillary barbels long, extending posteriorly beyond origin of anal fin. Outer and inner mental barbels long, extending posteriorly



Figure 7. – CT scan image of lower jaw of *Mastiglanis durantoni*, MZUSP 118118, paratype, lateral view, left side, anterior to left. Abbreviations: aa, anguloarticular; den, dentary; lsp, opening for latero-sensory pore; tr, trabeculae.

slightly beyond bases of pelvic- and pectoral-fins, respectively. Branchiostegal membranes medially overlapping, joined to isthmus region only at anteriormost portion. Seven branchiostegal rays (5 on anterior ceratohyal, 1 on posterior ceratohyal, 1 on intervening cartilage). Eleven slender gill rakers on first branchial arch, ten on first ceratobranchial plus one at angle formed with first epibranchial (sometimes a vestigial one on epibranchial, near its articulation with ceratobranchial). Cranial fontanel long, interrupted by epiphyseal bridge just behind eyes (Fig. 8). Width of fontanel mostly even along its length, slightly narrower near anterior end. Supraoccipital process large and wide, with parallel lateral edges and strongly concave, v-shaped distal margin. Bones of cranial roof thin, without ornamentation (Fig. 8A, B). Frontals, sphenotics, pterotics, and supraoccipital joined via overlapping joints. Nasal bones very elongate, anteriorly reaching anterior portion of mesethmoid and then curved laterally along anterior margin of mesethmoid cornua. Infraorbital bones composed of five elements: first infraorbital (with tiny transversal ossified canal medially-directed), and three subsequent long tubular infraorbitals (posteriormost onestrongly angled). Dorsal fin large, quadrangular in overall shape with distal margin gently concave, with I + 6 (*) rays. First dorsal-fin element (homologous to second dorsal-fin spine in the generalized siluriform condition) segmented, rigid proximally for as long as first branched element, and with distal portion produced into long and flexible filament reaching to anterior third of adipose-fin. First and second branched dorsal-fin elements also longer than others. Locking element (spinelet, or first dorsal-fin spine in generalized siluriform condition) absent (Fig. 8A, B). Seven dorsal-fin pterygiophores articulating with bifid neural spines of vertebrae 6 through 12-13. Pectoral fin scythe-shaped with $I + 8(2^*)$ or I + 9(1). First element unfused, segmented, non-serrated, with basal portion (equivalent to length of first branched element) rigid and distal por-



Figure 8. – CT scan image of skull and anterior portion of vertebral column and dorsal fin of *Mastiglanis durantoni*, MZUSP 118118, paratype. A: Dorsal view; B: Right lateral view; C: Ventral view. Anterior to top. A more detailed view of the Weberian complex is provided in Fig. 13. Abbreviations: af, anterior fontanel; bo, basioccipital; epi, epioccipital; ex, exoccipital; fr, frontal; le, lateral ethmoid; me, mesethmoid; np1-2, nuchal plates 1 and 2; ns, neural spine; orb, orbitosphenoid; pa, parasphenoid; par, parapophysis; pf, posterior fontanel; plr, pleurar rib; pro, prootic; pt, pterotic; ptr, pterosphenoid; pts, posttemporo-supracleithrum; sn, supraneural; soc, supraoccipital; socs, supraoccipital spine; sph, sphenotic; vc5-9, vertebral centra 5 to 9; vo, vomer; wc, Weberian complex.

tion filamentous (Figs 1, 2), the tip of which extends beyond vertical though anal-fin origin or to anterior third of adipose fin. Postcleithral process small, straight and spine-like, with very fine tip. Pelvic fin large, with I + 5 rays, its origin at vertical though middle of dorsal-fin base. Anal-fin rays: ii + 7 (3*), (plus 1 rudimentary anterior ray); anal fin with rounded margin in lateral profile. Nine blade-like pterygiophores between hemal spines of vertebrae 22 through 28. Adipose fin large, isosceles-triangle shaped, with smallest side leading, its origin slightly anterior to vertical through origin of

anal fin (Fig. 1). Posterior edge of adipose fin slightly concave, with small posterior free flap. Caudal fin deeply forked, its lobes equal in length. Principal caudal rays 8/9 (*) and procurrent caudal rays 12 dorsal and 12 ventral (confirmed in 2 c&s paratypes). Hypurals 1 and 2, and 3, 4, and 5 fused. Parahypural separate. One large epural. Six pairs of pleural ribs associated with parapophyses of vertebrae 6 to 11. First complete haemal spine on vertebrae 13. Distal extremities of four anterior pleural ribs strongly expanded, with scythe-like aspect (Fig. 8B). Total vertebrae 38.

Pigmentation in alcohol

Overall body colour pale vellowish (translucent in life and white immediately after preservation), with very reduced dark pigment, restricted to dorsal half of body and head. Dorsal trunk region with indistinct disperse scattering of individual dark chromatophores. Seven concentrations of dark pigment on body: one between head and dorsal fin (just behind nape), one in front of dorsal-fin origin, one along bases of last three branched dorsal-fin rays (one in each ray base in some specimens), one between dorsal and adipose fin, one just behind the adipose-fin origin, one on the posterior point of adipose-fin base, and one on caudal peduncle. Laterally, sparse cloud of chromatophores concentrated along the horizontal septum, forming faint longitudinal band, expanded as dark triangle over hypural plate. Some scattered melanophores on top of head region, along path of infraorbital canals and over cheek, forming thin dark outline of olfactory chamber. Dorsal part of maxillary barbels with some dark pigment. Adipose fin with few irregularly distributed melanophores. Dorsal-, pectoral-, and caudal-fin rays with few isolated dark chromatophores on some rays, with interradial membranes hyaline.

Pigmentation in life (based on photographs of one live specimen; Fig. 9)

Body partly translucent, dusky tan-yellowish. Welldefined elongate dark fields along base of dorsal fin, anterior third of base of adipose fin and posterior three-quarters of base of anal fin. A round dark spot at base of caudal fin, slightly displaced towards ventral lobe. Faint irregular dark fields on sides of body, formed by concentrations of internal dark chromatophores on sagittal plane visible by transparency. Barbels iridescent white. Fins transparent, with first ray of dorsal fin light tan. Dorsal aorta visible by transparency as thin dark midlateral line along most of body.

Etymology

The species name is dedicated to Michel Duranton, who collected with the second author the first specimens of the species, in recognition of his fascinating work on the fauna of French Guiana.

Distribution

Preserved specimens come from two small unnamed creeks, one tributary to the Tampok River and the other to the Grand Inini River (Le Bail *et al.*, 2000). Additionally, the species was seen and photographed in the Waki River (Melki, 2016), but no specimens were preserved from that locality. All sites are within a ca. 60 km radius. The Tampok, Waki and Grand Inini are independent tributaries to the Maroni River in French Guiana (Fig. 10).





Figure 9. – Live specimen of *Mastiglanis durantoni* n. sp, lateral view, French Guiana (photo by P.Y. Le Bail). Specimen not preserved.



Figure 10. – Geographical distribution of *Mastiglanis durantoni* n. sp.

Ecological notes

The species was found in the dry season in small clear water tributaries (depth 30-50 cm) on substrate composed of pebbles and sand, with slow current. It co-occurred with 39 to 49 other species, several of which are catfishes: *Chas*-

mocranus longior Eigenmann, 1912; Pimelodella cristata (Müller & Troschel, 1849); Pimelodella geryi Hoedeman, 1961; Pimelodus ornatus Kner, 1858; Ituglanis amazonicus (Steindachner, 1882); Bunocephalus amaurus Eigenmann, 1912; Callichthys callichthys (Linnaeus, 1758); and Corydoras guianensis Nijssen, 1970.

The feeding habits of *M. durantoni* are unknown at present. Its closest relative, M. asopos, is a carnivore, which feeds on trichopteran, ephemeropteran, chironomid and ceratopogonid larvae and small adult beetles (Zuanon et al., 2006). Oral structure and dentition, as well as habitat, suggest that a similar diet is expected for M. durantoni. Mastiglanis asopos is reported to employ a peculiar sit-and-wait foraging tactic: poised on the bottom and supported by a tripod formed by its pelvic and anal fins, the fish spreads its long barbels and the filamentous dorsal and pectoral-fin rays, thus forming a "drift-trap" which helps it to intercept and lunge at passing food items (Zuanon et al., 2006). In view of the similar morphology of the relevant anatomical parts in *M. durantoni*, it is expected to display the same behaviour. Mastiglanis asopos often co-occurs with Imparfinis pristos, Characidium pteroides, Pygidianops amphioxus and species of Gymnorhamphichthys in its psammic habitat. All those associated taxa are absent from the localities of M. durantoni and have so far not been recorded from the Maroni system or French Guiana (Le Bail et al., 2000). So, it seems that *M. durantoni* is the only narrowly specialized psammophilic fish species in its habitat.

DISCUSSION

Inclusion of the new species in *Mastiglanis* is unproblematic since it is evidently the closest relative of *M. asopos*. All characters originally proposed by Bockmann (1994) as autapomorphies for *M. asopos* are also shared by *M. duran*-

Figure 12. – CT scan image of suspensorium of *Mastiglanis durantoni*, MZUSP 118118, paratype, lateral view. Anterior to left. Abbreviations: ent, entopterygoid; hy, hyomandibula; io, interopercle; mt, metapterygoid; op, opercle; po, preopercle; qu, quadrate; sbpo, subpreopercle; spo, suprapreopercle.

Figure 11. – CT scan image of mesethmoid and premaxilla of *Mastiglanis durantoni*, MZUSP 118118, paratype, dorsal view. Anterior to top. Abbreviations: me, mesethmoid; pm, premaxilla.

toni, making them synapomorphies for Mastiglanis. These include the pronounced reduction of integumentary pigmentation (Figs 1, 2, 9; homoplastic within heptapterids with some unrelated troglobitic forms); the filamentous first rays of the dorsal and pectoral fins (Figs 1, 2; homoplastic with some species of Pimelodella; cf. Bockmann, 1994); the anterior nostrils further apart than the posterior ones (anterior internarial distance 1.5 times or more than posterior one); the eyes close together at the midline (interorbital distance approximately 10% of HL; Fig. 2A); the presence of a plate-like process at the anteromedial margin of the premaxilla (Figs 6, 10); the angled mesethmoid cornu, which bends abruptly laterally at midlength (Fig. 5; this trait is attenuated in *M. durantoni* because of the expansion of the cornua); the elongate, roughly rectangular metapterygoid (Fig. 12); the dorsal flange of the opercle in the same plane as the rest of





the bone (Fig. 12; this corresponds to the region parallel and adjacent to the dorsal margin of the opercle and marks to the insertion of the levator operculi muscle); and the ventrallycurved posterior portion of the opercle (in specimens examined, this is actually a concave portion of the ventral margin of the opercle, rather than an actual ventral deflection of the bone; Fig. 12). Each of those synapomorphies fits the general pattern proposed in Bockmann (1994) and requires no further discussion. Likewise, the combination of characters of broader significance displayed in M. durantoni does not depart significantly from those in *M. asopos*, and thus does not cast doubt on the hypothesized phylogenetic position of Mastiglanis among heptapterids. Mastiglanis durantoni shares all synapomorphies for the Heptapteridae (then known as Rhamdiinae; Lundberg and McDade, 1986; Lundberg et al., 1991): the posterior limb of the fourth transverse process of the Weberian complex laterally expanded dorsal to the swimbladder and notched once to multiple times (Fig. 13); the neural spines of the complex centrum conjoined by a straight-edged horizontal or slanted bony lamina; the process for the insertion of the levator operculi muscle on the posterodorsal corner of the hyomandibula greatly expanded (Fig. 12); the quadrate with a free dorsal margin and bifid shape, its posterior and anterior limbs articulating separately with the hyomandibula and metapterygoid (Fig. 12); the presence of an anteriorly-recurved process on the ventrolateral corner of the mesethmoid (Fig. 11; the process is not anteriorly-curved in specimens of M. durantoni and in some of M. asopos examined). Mastiglanis durantoni also fits the heptapterid subgroup called the Nemuroglanis subclade (Ferraris, 1988; Bockmann, 1994), sharing all its synapomorphies originally proposed by Ferraris (1988): the laminar portion of the transverse process of the complex centrum, posterior to the branched segment, triangular in shape and extending nearly to the lateral tip of the transverse process of the fifth vertebra (Figs 8C, 13); the first dorsal-fin pterygiophore inserted posterior to the Weberian complex, usually dorsal to vertebrae 7 to 10; the dorsal-fin spine thin and flexible and the dorsal-fin lock absent (Fig. 8A, B); and the distal half of the pectoral-fin spine thin and flexible. Additional synapomorphies for the Nemuroglanis subclade subsequently proposed by Bockmann (1994) are also clearly present in *M. durantonii*: mesocoracoid modified into a wide band; two posterior proximal pectoral-fin radials enlarged and flattened; scapulo-coracoid dentations reduced to three; contact surface between cleithra reduced; absence of a pointed process projected posteroventrally from the coracoid keel; posterior swimbladder chamber absent; nasal bone elongated and weakly ossified; absence of dorsal ridges extending from the neural arch of the fourth vertebra to anterior limbs of the transverse process of the fourth vertebra (Fig. 13); deep medial notch dividing the posterior limb of the fourth transverse process into two divergent, approximately symmetrical



Figure 13. – CT scan image of posterior portion of skull and anterior part of vertebral column of *Mastiglanis durantoni*, MZUSP 118118, paratype, ventral view. Anterior to top. Abbreviations: bo, basioccipital; ex, exoccipital; fr, frontal; pa, parasphenoid; par, parapophysis; plr, pleural rib; pro, prootic; pt, pterotic; ptr, pterosphenoid; pts, posttemporo-supracleithrum; sph, sphenoic; tp4a, anterior ramus of transverse process of vertebra 4; tp4p, posterior ramus of transverse process of vertebra 4; tp5, transverse process of vertebra 5; tr, tripus; trs, transscapular process; vc5-7, vertebral centra 5 to 7.

long arms (Fig. 13); tips of vertebral parapophyses expanded into concave cups acommodating the proximal extremities of pleural ribs (Figs 8C, 13); hemal and neural spines of the caudal vertebrae oriented at ca. 35° angle relative to the vertebral column; hemal and neural spines of posterior precaudal vertebrae robust.

The status of M. durantoni as a species distinct from M. asopos is corroborated by a number of traits for which the two species are separated by non-overlapping morphometric and meristic values such as in caudal peduncle depth, snout length, head depth and procurrent caudal fin ray counts (cf. Diagnosis above). In addition to those, there are some qualitative traits in internal anatomy, such as the shape of the posterior margin of the supraoccipital process and of the mesethmoid cornua. The first of those needs some comment,

Figure 14. – Schematic illustrations of the occipital process and part of posterior cranial fontanel in species of *Mastiglanis*. A: *Mastiglanis durantoni*, MZUSP 118119, paratype; **B-G**: *M. asopos*, B: MZUSP 93307 (Rio Negro basin), C: MZUSP 81411 (Rio Negro basin), D: MZUSP 86958 (Rio Preto da Eva basin), E-G: MZUSP 97150 (Rio Xingu basin). Scale bars = 1 mm.



because the shape of the occipital process in *M. asopos* is extremely variable. The distal margin of the process in the latter species can be truncate, concave semicircular, concave lunate or notched to varying degrees (Fig. 14B-G). Such variation is seen even among specimens within the same population. In no case, however, is the process deeply notched as in *M. durantoni*, where the tip of the occipital process is v-shaped and deeply angled (Figs 4, 14A). Thus, the shape of the occipital process in M. durantoni lies outside the range of variation seen in M. asopos, further corroborating their status as a separate species. Each of the identified diagnostic characteristics distinguishes 100% of specimens of each species. In combination, this set of traits provides consistent evidence that *M*. *durantoni* is evolving as a lineage separate from *M. asopos*. Also, we found no evidence that the degree of difference attenuates with geographical proximity, with specimens of *M. asopos* from the Orinoco and Guyana no more similar morphologically to *M. durantoni* than those at more distant localities. An understanding of the details of the evolution of Mastiglanis lineages will require extensive sampling and detailed character analysis in combination with data from adequate genetic markers.

The wide geographical range of *M. asopos* contrasts markedly with the tiny and borderline distribution of *M. durantoni*. The new species is not only restricted to the Maroni drainage, but also known therein only in three localities in upper-reach tributaries. Considering the amount of ichthyological sampling made in French Guyana for the past four decades, this is unlikely to be a result of sampling bias and *M. durantoni* seems indeed to have a very narrowly endemic distribution. This indicates that *M. durantoni* is probably descendant of an outlying population long isolated in the upper reaches of the Maroni basin from the rest of the *Mastiglanis* lineage, and now differentiated into a separate species. Relevant to that discussion is the differences in phyletic status between the two species are now recognized in Mastiglanis. Some of the conditions which distinguish M. durantoni from M. asopos can be considered as autapomorphies for the former species on the basis of broader comparisons within Heptapteridae. The slender caudal peduncle and long snout depart from conditions widespread in other heptapterids of the Nemuroglanis subclade phylogenetically close to Mastiglanis (cf. Bockmann, 1998). The presence of such autapomorphic conditions suggests that M. durantoni is a historically-cohesive unit, *i.e.* a monophyletic species. The opposite applies to *M. asopos*. With the discovery of a second species in the genus, all autapomorphies previously proposed for *M. asopos* become in fact synapomorphies for the genus and the species is left without identified autapomorphies. That fact, in combination with its wide geographical distribution in comparison with its sister species, make it likely that *M. asopos* is a metaspecies (Donoghue, 1985; de Pinna, 1999). As such, it is possible that more detailed studies, perhaps on the basis of adequate genetic markers, will demonstrate that *M. asopos* is a species complex, with some subunits more closely related to M. durantoni than to other populations currently in M. asopos.

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