

## ***Gymnotus ardilai*: a new species of Neotropical electric fish (Ostariophysi: Gymnotidae) from the Rio Magdalena Basin of Colombia**

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### **Abstract**

A new species of Neotropical electric fish, *Gymnotus ardilai*, is described from the Río de Oro near Bucaramanga in the Rio Magdalena Basin. *Gymnotus ardilai* is distinguishable from all congeners by the following combination of characters: 1, a clear patch at the caudal end of the anal fin; 2, two laterosensory canal pores (from the preopercular-mandibular series) in the dorso-posterior portion of the preopercle; 3, progressive loss of alternating dark and light pigment bands with the size; 4, a long head (10.2 – 11.2 % total length); 5, many (9–10) scales over anal fin pterygiophores; 6, few (47–48) pored lateral-line scales to first ramus; 7, low (84 n = 1) total number of pored lateral-line scales ; and, 8, relatively large eye (orbital diameter 8.5–9.0 % HL). *Gymnotus ardilai* is the first record of the genus from the Magdalena Basin and represents a unique record of Gymnotiformes from over 800 meters above sea level.

**Key words:** Gymnotiformes, *Gymnotus*, Magdalena, Colombia

### **Introduction**

The weakly electric Neotropical fish genus *Gymnotus* has been the subject of several taxonomic studies in recent years (Mago-Leccia 1994; Albert & Miller 1995; Campos da Paz 1996; Campos da Paz & Costa 1996; Fernandes-Matioli et al., 1998a; 1998b; Albert et al., 1999; Campos da Paz 2000; Fernandes-Matioli et al., 2000; Albert 2001; Albert & Crampton 2001; Fernandes-Matioli & Almeida-Toledo 2001; Campos da Paz 2002; Albert & Crampton 2003; Campos da Paz 2003). Until recently *Gymnotus* was recognized as the only genus in the family Gymnotidae. The monotypic genus *Electrophorus* Gill, comprising the single strongly electric species *Electrophorus electricus* (L.) was recently included in the Gymnotidae (Albert 2001).

**TABLE 1.** Twenty seven valid species of *Gymnotus* with affiliation to species-groups (see text) and geographical range: Geographical areas follow Albert and Crampton (2003): EA, Eastern Amazon; GU, Guyana Shield and Orinoco basin; MA, Middle America; MD, Madeira; NE, northeastern Brazil; PA, Paraguay-Paraná; PI, Piauí; PS, Pacific Slope; RO, Roraima; SE, southeast coast Brazil, Uruguay; WA, Western Amazon.

Group	Species	Geographical range
cylindricus	<i>G. cylindricus</i> LaMonte, 1935	MA
	<i>G. maculosus</i> Albert & Miller, 1995	MA
pantherinus	<i>G. anguillaris</i> Hoedeman, 1962	GU, MD
	<i>G. cataniapo</i> Mago-Leccia, 1994	GU
	<i>G. coatesi</i> LaMonte, 1935	EA, WA
	<i>G. coropinae</i> Hoedeman, 1962	GU, EA, MD, WA
	<i>G. javari</i> Albert, Crampton & Hagedorn, 2003	WA
	<i>G. jonasi</i> Albert & Crampton, 2001	WA
	<i>G. melanopleura</i> Albert & Crampton, 2001	WA
	<i>G. onca</i> Albert & Crampton, 2001	WA
	<i>G. panamensis</i> Albert & Crampton, 2003	MA
	<i>G. pantherinus</i> (Steindachner, 1908)	SE
carapo	<i>G. pedanopterus</i> Mago-Leccia, 1994	EA, GU
	<i>G. stenoleucus</i> Mago-Leccia, 1994	GU
	<i>G. arapaima</i> Albert & Crampton, 2001	MD, WA
	<i>G. bahianus</i> Campos-da-Paz & Costa, 1996	NE
	<i>G. carapo</i> Linnaeus, 1758	EA, GU, MD, PI, RO, WA
	<i>G. choco</i> Albert, Crampton & Maldonado, 2003	PS
	<i>G. diamantinensis</i> Campos da Paz, 2002	EA
	<i>G. esmeraldas</i> Albert & Crampton, 2003	PS
	<i>G. henni</i> Albert, Crampton & Maldonado, 2003	PS
	<i>G. inaequilabiatus</i> (Valenciennes, 1847)	PA
	<i>G. mamiraua</i> Albert & Crampton, 2001	MD, WA
	<i>G. paraguensis</i> Albert & Crampton, 2003	PA
	<i>G. sylvius</i> Albert <i>et al.</i> 1999	PA, SE
	<i>G. tigre</i> Albert & Crampton, 2003	EA, WA
	<i>G. ucumara</i> Crampton, Lovejoy & Albert, 2003	WA

There are currently 27 valid species of *Gymnotus* found throughout the humid Neotropics (Albert 2003), of which nine are found in Colombia (Maldonado-Ocampo & Albert 2003). Albert (2001) and Albert and Crampton (2001) summarize the diagnostic characters of *Gymnotus*. Albert and Miller (1995) and Albert (2001) recognize three species groups within the genus based on color pattern and body proportions. These are the *G. cylindricus*, *G. pantherinus*, and *G. carapo* species-groups. The species composition and geographical range of these groups are summarized in Table 1. The *G. cylindricus* species-

group is endemic to both Atlantic and Pacific drainages of Middle America and comprises just two species. The *G. pantherinus* species-group is represented by 12 species with distributions from Panama to Paraguay. The *G. carapo* species-group is endemic to South America and is represented by 13 species distributed from the Pacific slope of Colombia to the Pampas of Argentina. Species in the *G. carapo* species-group can be distinguished from those in the other two species-groups by the possession of: a clear or pale patch near the caudal end of the anal fin, most visible in juveniles and subadults (60–150 mm); two (vs. one) laterosensory canal pores from the preopercular-mandibular series in the dorso-posterior portion of preopercle.

Here we describe a new species of *Gymnotus* from where the Río de Oro meets the Río Lebrija, a locality in the Río Magdalena Basin. The new species is the first record of *Gymnotus* from the Río Magdalena Basin and represents a unique record of Gymnotiformes from over 800 meters above sea level.

### Materials and methods

Specimens examined belong to the ichthyological collection at the Instituto Alexander von Humboldt (IAvHP); two lots with five specimens; one female, two males and two very small immature specimens (all individuals identified by means of gonad inspection). Due to the small size of the two juveniles (less of 34 mm TL) the same were not include in the measurements.

Comparative materials have been examined from museum collections and reported in: (Albert et al., 1999; Albert 2001; Albert & Crampton 2001; Albert & Crampton 2003; Crampton et al., 2003). Measurements and counts are abbreviated in Tables 2 and 3 respectively, and follow Albert & Crampton (2003). Morphometric data were captured as point-to-point linear distances from standardized landmarks using digital calipers to the nearest 0.1 mm. Total Length (TL), from the tip of the snout (dorsal midline of upper jaw) to the end of the body. Body proportions reported include head length (HL), from posterior margin of bony operculum to tip of snout (dorsal midline of upper jaw); head depth (HD), vertical distance from occipital region to ventral region at the same point; head wide (HW), widest distance at the opercular region; postorbital length (PO), from posterior margin of bony opercle to posterior margin of eye; preorbital length (PR), from anterior margin of eye to tip of snout; body depth (BD), vertical distance from origin of anal fin to dorsal body border (with lateral line held horizontal); body width (BW), measured at the origin of anal fin; pectoral-fin length (P1), from dorsal border of fin base where it contacts cleithrum to tip of longest ray; interorbital distance (IO), between dorsomedial margins of eyes; size of branchial opening (BO), from posterodorsal to anteroventral extent of branchial fold; anal fin (AF) length of the anal fin; pre-anal distance (PA), from anterior insertion of anal fin to posterior margin of anus.

**TABLE 2.** Morphometric data for *Gymnotus ardilai*. See Material and Methods for morphometric abbreviations. TL and HL expressed in mm. Measurements in HL, or TL for HL%, BD %, BW%, and AF% in percentage. BD/BW expressed as a ratio.

	Holotype (female) IAvHP3477	Paratypes (males) IAvHP 4001	
TL	430	329	219.2
HL	47	33.7	24.5
HL%	10.9	10.2	11.2
PP%	28.3	30.6	22.4
MW%	46.2	51.6	42.4
PO%	59.8	63.5	63.7
IO%	47.7	47.5	39.2
DE%	8.5	8.9	9.0
BD%	12.3	11.4	13.2
BW%	10.1	6.9	6.4
BD/BW	1.2	1.7	2.1
HD%	67.4	71.2	65.7
HW%	77.4	70.0	61.2
BO%	38.3	31.2	38.8
PA%	82.3	70.6	65.7
P1%	34.9	52.8	38.8
AF%	79.2	84.2	83.8

**TABLE 3.** Meristic data for *Gymnotus ardilai*. See Material and Methods for abbreviations. TL expressed in mm.

	Holotype (female) IAvHP3477	Paratypes (males) IAvHP 4001	
TL	430	329	219.2
PIR	14	14	14
SAL	8	8	9
APS	10	10	9
PCV	34	-	-
PLR	48	47	48
PLL	84	-	-

Scale, lateral-line pore, and pectoral-fin ray counts were taken directly from ethanol preserved specimen under a dissecting microscope. Abbreviations used for meristic variables are: APS, number of anal-fin pterygiophore scales counted as the number of scale rows over the pterygiophores (counted from an origin vertically below the base of the first lateral line ramus); PCV, number of precaudal vertebrae including the five elements of the Weberian Apparatus (counts from a single radiograph of the holotype); P1R, number of

branched and unbranched pectoral-fin rays; PLL, number of pored lateral-line scales in posterior lateral line posterior to neurocranium; PLR, number of pored lateral line scales to first ventral ramus; SAL, number of scales above lateral line at midbody. Protocols for counting lateral-line rami are described in Albert *et al.* (1999). Counts of bilaterally paired series (APS, P1R, PLL, PLR, SAL) were taken on the left side.

***Gymnotus ardilai* new species**

(Figs. 1–3).

**Holotype.** — IAvHP 3477 (CAR 05), 430 mm TL. Female. Colombia, Santander, Girón, Río de Oro, collected by Carlos Ardila, 6 January 2000.

**Paratypes.** — IAvHP 4001 (2, 219.2–329 mm TL, males). Colombia, Santander, Girón, Río de Oro, collected by Carlos Ardila, 4 January 2004.

**Diagnosis.** — *Gymnotus ardilai* differs from all congeners in possessing the following unique combination of characters: 1, a clear patch at the caudal end of the anal fin; 2, two laterosensory canal pores (from the preopercular-mandibular series) in the dorso-posterior portion of the preopercle; 3, progressive loss of alternating dark and light pigment bands with the size, with no pigment bands in individuals more than 350 mm TL (a pattern that is readily distinguishable from all other described species of the *G. carapo*-species group except populations of *G. esmeraldas* from the Guayaquil basin); 4, a long head (HL 10.2–11.2 % TL total length vs. 7.9–11.8 % in all other species except *G. carapo* and *G. arapaima*); 5, many (9–10) scales over anal fin pterygiophores (vs. 4–9 in all other species except *G. arapaima*); 6, few (47–48) pored lateral-line scales to first ventral ramus (vs. 32–38 [median 37] in *G. mamiraua*, vs. 42–52 [median 48] in *G. carapo*, and vs. 50–64 in all other species); 7, a low (84 n = 1) total number of pored lateral-line scales (84 n = 1 vs. 93–108 [median 98] in *G. carapo*, and vs. 106–140 in all other species except *G. mamiraua*); and 8, a relatively large eye (orbital diameter 8.5–9.0 % HL vs. 6.0–7.0 % in *G. carapo*).

**Description.** Body shape and pigment patterns illustrated in Figs. 1 and 2. Morphometrics and meristics data for the holotype and paratypes are presented in Tables 2 and 3. Size of maturity and sexual dimorphism unknown. However, the holotype which corresponds to a female, presents a developed gonad that is present in 2/4 of the body and presents a yellow color. Scales cycloid, ovoid, present on entire post-cranial portion of body from nape to tip of caudal appendage. Scales on dorsal surface relatively large at midbody, eight to nine rows from lateral-line to dorsal midline. Scales small over pterygiophores, nine to 10 scale rows. Lateral-line scales approximately 4.3 mm high by 4.0 mm long in humeral region (n = 1); 5.6 mm high by 6.3 mm long at midbody (n = 1); 3 mm high by 3.5 mm long dorsal to anterior margin of clear patch on anal-fin (n = 1). Gape size in mature specimens large, extending beyond posterior nares. Mouth position superior, lower jaw longer than upper, rictus decurved. Chin fleshy and bulbous with thick pad of electroreceptor organs and support tissues overlying tip of snout and oral jaws. Anterior

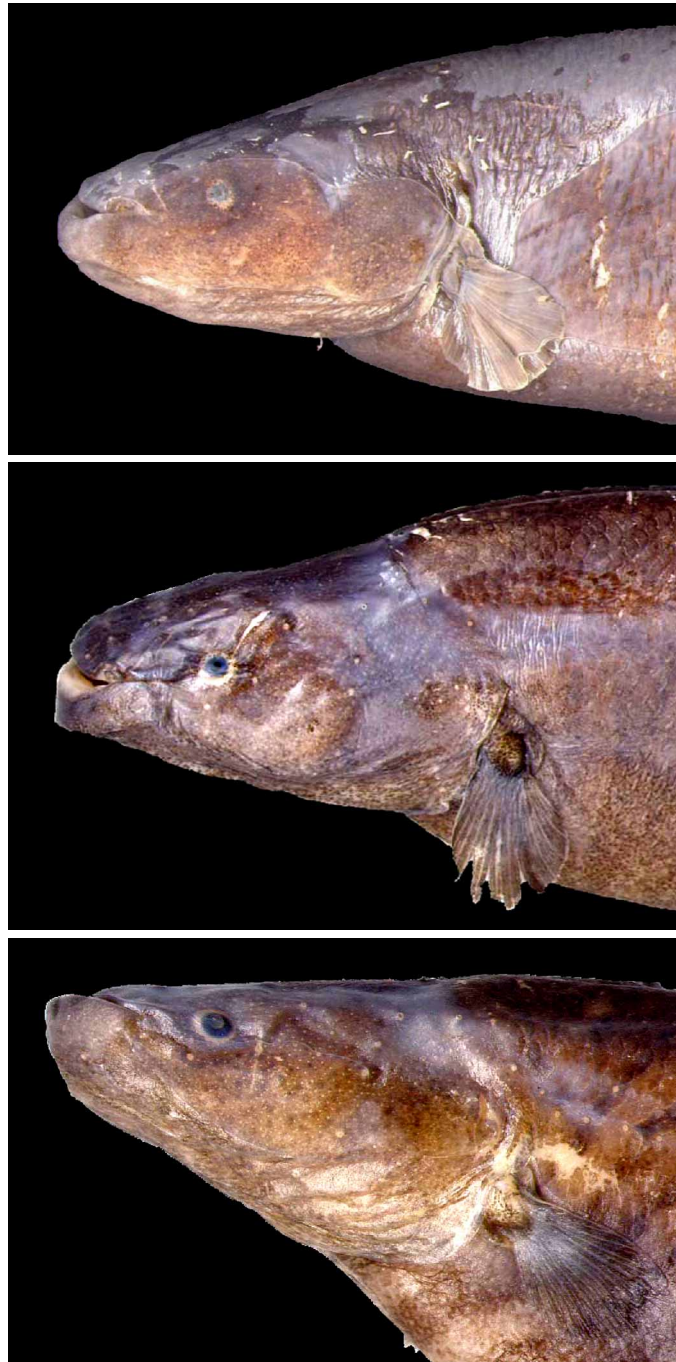
narial pore included within gape in large narial fold. Anterior nares large, subequal to diameter of eye. Branchial opening moderate (31.2–38.8 % HL). Circumorbital series ovoid. Ethmoid region between anterior nares moderate, its anterior margin rounded. Eye position lateral, lower margin of eye slightly ventral to rictus. Eye relatively large, orbital diameter 8.5–9.0 % HL. Premaxilla and dentary with one row of large, slightly recurved, conical teeth. Premaxilla with 14–22 ( $n = 2$ ) teeth disposed in single row along outer margin. Dentary with 17–26 ( $n = 3$ ) teeth disposed in single row along outer margin.



**FIGURE 1.** *Gymnotus ardilai*. Holotype IAvHP 3477 (CAR 05), female, 430 mm TL. Lateral view.



**FIGURE 2.** *Gymnotus ardilai*. Paratypes IAvHP 4001, males, (A) 219.2 mm TL, (B) 329 mm TL. Lateral view.



**FIGURE 3.** Head profiles of *Gymnotus ardilai*. (A) Holotype, (B) Paratypes.

**Color in life.** Head not banded, spotted or blotched, uniformly dark brown but slightly paler in gular region (Fig. 3). Numerous minute chromatophores speckled over branchiostegal membranes and ventral surface of head. Pectoral-fin rays dark brown or black, interradial membranes hyaline. Anal-fin never blotched, spotted or marked. Anal-



fin rays and membrane dark gray or black on anterior 80% of its length, translucent on posterior 20%. Color variation is progressively correlated with size with larger individuals losing the light bands. Juvenals (34 mm TL) with 15–17 thin well-defined pale bands (Fig. 4).



FIGURE 4. Lateral view of immature *G. ardilai*, 34 mm TL.

**Electric organ discharge.** Unknown

**Distribution.** *Gymnotus ardilai* is known only from the Río de Oro, where it meets the Río Lebrija, in the Magdalena Basin, Colombia (Fig. 5).

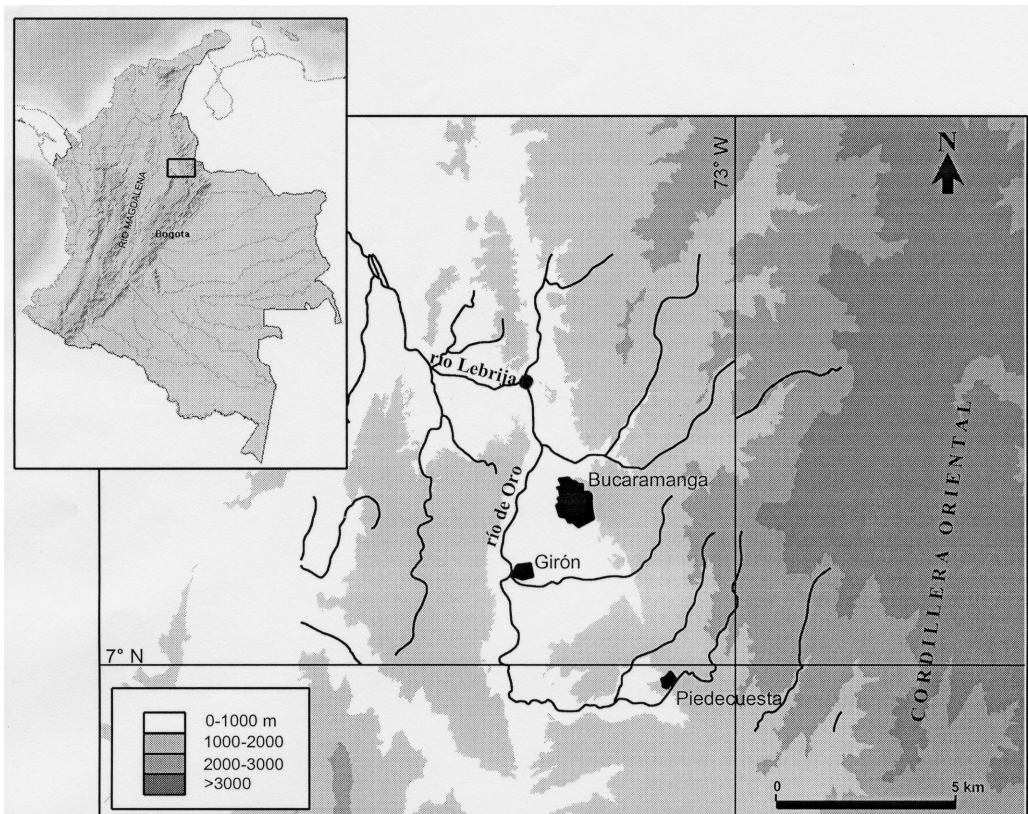


FIGURE 5. Map of Colombia illustrating the type locality ( ) of *Gymnotus ardilai* and 1: Bucaramanga city; 2: Pie de Cuesta; 3: Girón.



**Habitat and Ecology.** The type and only known locality is an Andean whitewater river (c.1000 meters above sea level, 1.5 meters deep) with low flow, low transparency and high sediment load. *Gymnotus ardilai* is found free swimming along the river margin. The species coexists with *Eigenmannia virescens*, *Pimelodella chagresi*, *Rhamdia quelen*, *Chaetostoma thomsoni*, *Dolicancistrus carnegiei*, *Geophagus steindachneri*, *Aequidens pulcher*, *Creagrutus magdalenae* and *Poecilia reticulata*. The type locality is heavily polluted from effluents of the municipalities of Pie de Cuesta, Floridablanca and Girón. The effect of pollution on the ecology of *G. ardilai* is unknown, although this species is very rarely collected and presumably present in low population densities. Examination of the stomach content of the Paratype (212.9 mm TL) shows a diet consisting mostly of aquatic invertebrates, especially larval Odonata.

**Common name.** Lamprea.

**Etymology.** Specific epithet in honor to Dr. Carlos A. Ardila Rodriguez, President of the Colombian Ichthyological Association (ACICTIOS), who has contributed to the knowledge of Colombian ichthyology.

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### Literature cited

- Albert, J.S. (2001) Species diversity and phylogenetic systematics of American knifefishes (Gymnotiformes, Teleostei). *Miscellaneous Publications Museum of Zoology, University of Michigan*, 190, 1–129.
- Albert, J.S. (2003) Gymnotiformes: Gymnotidae – ghost knifefishes. *In: Check List of the Freshwater Fishes of South and Central America*. Edipucrs, Porto Alegre, Brazil, pp. 497–502.
- Albert, J.S. & Crampton, W.G.R. (2001) Five new species of *Gymnotus* (Teleostei: Gymnotiformes) from an Upper Amazonian floodplain, with descriptions of electric organ discharges and ecology. *Ichthyological Exploration of Freshwaters*, 12 (3), 241–266.
- Albert, J.S. & Crampton, W.G.R. (2003) Seven new species of the Neotropical electric fish *Gymnotus* (Teleostei, Gymnotiformes) with a redescription of *G. carapo* (Linnaeus). *Zootaxa*, 287, 1–54.
- Albert, J.S., Fernandes-Matioli, F.M.D. & Almeida-Toledo, L.F. (1999) New species of *Gymnotus* (Gymnotiformes, Teleostei) from Southeastern Brazil: Towards the deconstruction of *Gymnotus carapo*. *Copeia*, 1999 (2), 410–421.
- Albert, J.S. & Miller, R.R. (1995) *Gymnotus maculosus*, a new species of electric fish (Chordata:

- Teleostei: Gymnotoidei) from Middle America, with a key to species of *Gymnotus*. *Proceedings of the Biological Society of Washington*, 108 (4), 662–678.
- Campos da Paz, R. (1996) Redescription of the Central American electric fish *Gymnotus cylindricus* (Ostariophysi: Gymnotiformes: Gymnotidae), with comments on character ambiguity within the ostariophysan clade. *Journal of Zoology, London*, 240, 371–382.
- Campos da Paz, R. (2000) Taxonomic status of *Rhamphichthys cingulatus* Brind and a more precise assignment of the type-locality of *Gymnotus coatesi* LaMonte (Ostariophysi: Gymnotiformes). *Copeia*, 2000 (4), 1114–1117.
- Campos da Paz, R. (2002) *Gymnotus diamantinensis*, a new species of electric knifefish from Upper Rio Arinos basin, Brazil (Ostariophysi: Gymnotidae). *Ichthyological Exploration of Freshwaters*, 13 (2), 185–192.
- Campos da Paz, R. (2003) Family Gymnotidae (naked-back knifefishes). In: Reis, R.E., Kullander, S.O., & Ferraris, C.J. (Ed) *Checklist of the freshwater fishes of South and Central America*, Edipucrs, Porto Alegre, Brazil, pp. 483–486.
- Campos da Paz, R. & Costa, W. J. E. M. (1996) *Gymnotus bahianus* sp. nov., a new gymnotid fish from Eastern Brazil (Teleostei: Ostariophysi: Gymnotiformes), with evidence for the monophyly of the genus. *Copeia*, 1996 (4), 937–944.
- Crampton, W.G.R., Lovejoy, N. & Albert, J.S. (2003) *Gymnotus ucamara*: a new species of Neotropical electric fish from the Peruvian Amazon (Ostariophysi: Gymnotidae), with notes on ecology and electric organ discharges. *Zootaxa*, 277, 1–18.
- Fernandes-Matioli, F.M.C., Almeida-Toledo, L.F. & Toledo-Filho, S.A. (1998a) Natural triploidy in the Neotropical species *Gymnotus carapo* (Pisces: Gymnotiformes). *Caryologia*, 51, 319–322.
- Fernandes-Matioli, F.M.C., Marchetto, M.C.N., Almeida-Toledo, L.F. & Toledo, S.A. (1998b) High intraspecific karyological conservation in four species of *Gymnotus* (Pisces : Gymnotiformes) from Southeastern Brazilian basins. *Caryologia*, 51, 221–234.
- Fernandes-Matioli, F.M.C., Matioli, S.R. & Almeida-Toledo, L.F. (2000) Species diversity and geographic distribution of *Gymnotus* (Pisces: Gymnotiformes) by nuclear (GGAC)(n) microsatellite analysis. *Genetics and Molecular Biology*, 23, 803–807.
- Fernandes-Matioli, F.M.C. & Almeida-Toledo, L.F. (2001) A molecular phylogenetic analysis in *Gymnotus* species (Pisces: Gymnotiformes) with inferences on chromosomal evolution. *Caryologia*, 54, 23–30.
- Mago-Leccia, F. (1994) Electric fishes of the continental waters of America. *Biblioteca de la Academia de Ciencias Fisicas, Matematicas y Naturales*, Caracas, 29, 1–206.
- Maldonado-Ocampo, J.A. & Albert, J.S. (2003) Species diversity of Gymnotiform fishes (Gymnotiform, Teleostei) in Colombia. *Biota Colombiana*, 4 (2), 145 – 163.