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Sternopygus branco: A New Species of Neotropical Electric Fish (Gymnotiformes: Sternopygidae) from the Lowland Amazon Basin, with Descriptions of Osteology, Ecology, and Electric Organ Discharges

WILLIAM G. R. CRAMPTON, KEVIN G. HULEN, AND JAMES S. ALBERT

***Sternopygus branco* n. sp. is described from the Amazon River between its confluences with the Rios Japurá and Negro, and from the lower 100 km of the Rio Negro. This species is described using features of external morphology, meristics, pigmentation, osteology, and electric organ discharges (EODs). The new species is diagnosed by a very low EOD repetition rate (24–35 Hz vs approximately 40–300 Hz in congeners); very pale pigmentation on the entire body surface in live specimens; the absence of a pale lateral stripe along dorsal margin of anal-fin pterygiophores (present in adults and/or juveniles in all congeners); a slender body (body depth 8.3–10.9% length to end of anal fin vs 10.3–16.1% in congeners); posterior margins of cleithrum and supracleithrum short and robust. *Sternopygus branco* is found in the main river channels of whitewater and blackwater rivers and in adjacent side channels. It is not known from seasonally flooded forests or terra firme stream systems. *Sternopygus branco* is able to rapidly modulate the amplitude of its EOD.**

***Sternopygus branco* é descrita como uma espécie nova proveniente do rio Amazonas entre sua confluência com o rios Japurá e com o rio Negro, e também do trecho baixo do rio Negro, até 100 km da sua foz. Esta espécie é descrita com base em características de morfologia externa, dados merísticos, pigmentação, osteologia e propriedades da descarga do órgão elétrico (DOE). *Sternopygus branco* diferencia-se de outros membros de *Sternopygus* pelas seguintes características: frequência muito baixa da DOE (24–35 Hz contra 40–300 Hz em outras espécies); pigmentação muito pálida na superfície inteira do corpo em espécimens vivos; ausência de listra lateral pálida ao longo da margem dorsal dos pterigióforos da nadadeira anal (ausente em adultos e/ou juvenis de outras espécies); corpo alongado (altura do corpo 8.3–10.9% do comprimento até o limite posterior da nadadeira anal contra 10.3–16.1% em outras espécies); margem posterior do cleitro e supracleitro curta e robusta. O habitat de *S. branco* constitui-se de calhas principais e braços rasos adjacentes de rios de água branca e água preta. Esta espécie não ocorre em florestas sazonalmente alagáveis nem tampouco em riachos (igarapés) de terra firme. *Sternopygus branco* é capaz de modular o amplitude da DOE espontaneamente.**

THE weakly electric fish genus *Sternopygus* Müller and Troschel, 1849, occurs in freshwaters throughout the lowland Neotropics, from the Río Tuyra of the Pacific coast of Panamá, to the Río de la Plata in Argentina (Eigenmann and Ward, 1905; Eigenmann and Allen, 1942; Albert and Fink, 1996). Ellis (1913) recognized *Sternopygus* species by the simultaneous presence of a free orbital margin, teeth on both jaws, a short robust snout, by the absence of a caudal fin, and by the absence of a broad pale band along the lateral line. Species of *Sternopygus* are found in most of the major Neotropical aquatic habitats, including the main channel of major rivers (Cox Fernandes, 1998), small streams, rivers, and lakes (Albert and Fink, 1996; Alves-Gomes, 1997; Crampton, 1998a) and in the várzea floodplains of major whitewater river systems (Crampton, 1996a, 1999).

Twelve nominal species of *Sternopygus* have been proposed to date, of which six are recognized as valid in the most recent taxonomic revision of the Gymnotiformes (Albert, 2001). Ellis (1913) grouped the seven nominal species of *Sternopygus* known at the time as synonyms of the type species *Sternopygus macrurus* (Bloch and Schneider, 1801). Mago-Leccia (1994) synonymized three nominal species with *S. macrurus* and considered four nominal species as geographical variants of *Sternopygus aequilabiatus* (Humboldt and Bonpland, 1811). Mago-Leccia (1994) also retained *S. obtusirostris* Steindachner, 1881, as a valid species, and described a new species, *Sternopygus astrabes* Mago-Leccia, 1994. Albert and Fink (1996) modified Mago-Leccia's taxonomy by synonymizing *S. obtusirostris* with *S. macrurus* and by describing a new species, *S. xingu* Albert and Fink, 1996. Albert (2001) further

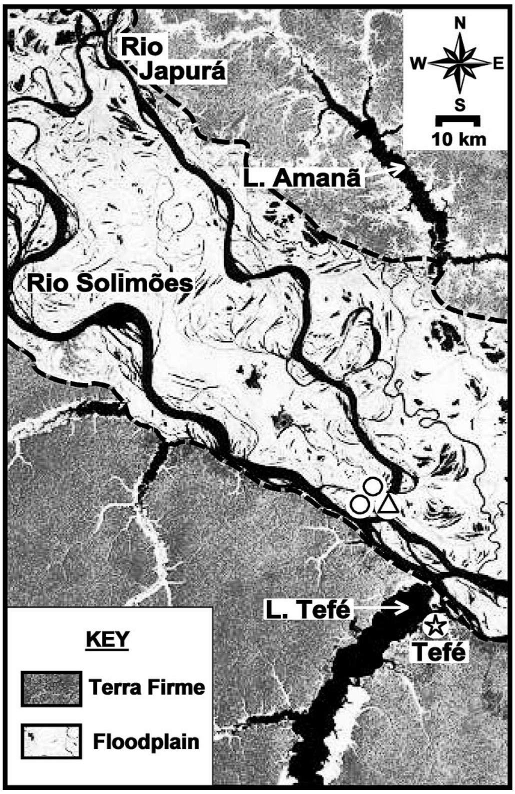

Fig. 1. Map of Tefé area, Brazil showing positions of the holotype (white triangle) and paratype localities (white circles) of *Sternopygus branco* n. sp. Some symbols represent more than one sample station. The base map is a NASDA JERS-1 SAR radar image from June 1995. Flooded forests appear white illustrating the maximum extent of the annual flood cycle. The area between the thick dotted lines is the Holocene alluvial floodplain (várzea) of high conductivity rivers. River systems draining the Quaternary peneplain to the north and south of the várzea contain low-conductivity blackwaters.

modified the taxonomy of *Sternopygus* by recognizing two species in the *S. aequilabiatus* complex (*S. aequilabiatus* and *S. arenatus* Eydoux and Souleyet, 1841) and by recognizing an additional valid species, *Sternopygus castroi* Triques, 2000.

A new and rare species, *Sternopygus branco*, is described in this paper from the main channel of large whitewater and blackwater rivers in the lowland Central Amazon basin. This brings the total number of valid species of *Sternopygus* to seven. This contribution represents part of an ongoing evolutionary study of the species and electric signal diversity of gymnotiform fishes from the Brazilian Amazon Basin in the vicinity of Tefé, Amazonas (Crampton, 1998a,b; Albert and Crampton, 2001). Following eight years of intensive sampling, the total sampled diversity of gymnotiform fishes in the Tefé region is at least 78 species.

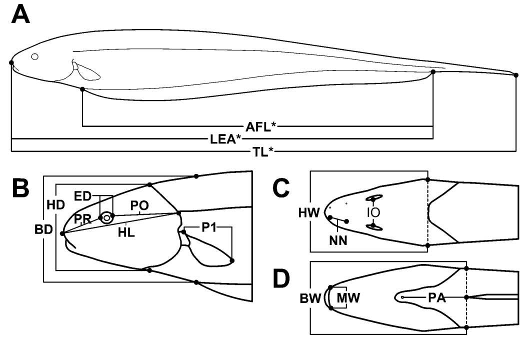

Fig. 2. Diagrammatic representation of the body (A) and head of *Sternopygus* in left lateral (B), dorsal (C), and ventral (D) views showing landmarks for morphometric measurements reported. Measurements with an asterisk taken with ruler to nearest millimeter. Other measurements taken point-to-point with needle-point calipers to nearest 0.01 mm. Abbreviations are (A): TL, total length; LEA, length to end of anal fin; AFL, anal fin base. (B): BD, body depth; HD, head depth; PR, preorbital head length; ED, eye diameter; HL, head length; PO, postorbital head length; P1, pectoral-fin length. (C): NN, internarial length; IO, interorbital distance; HW, head width. (D): MW, mouth width at rictus; PA, preanal distance; BW, body width.

Materials and Methods

Fourteen specimens of *S. branco* were captured and their electric organ discharges (EODs) recorded and digitized as part of a long-term (1993–2002) multihabitat sampling program undertaken by one of us (WGRC) near the town of Tefé, Amazonas, Brazil (Fig. 1). Specimens were captured using seine nets (5 mm mesh, 30–50 × 4–8 m) in beaches, shallow water, and floating meadows of macrophytes, and trawl nets (10 mm cod-end mesh, 3 m mouth) employed at the bottom of rivers at depths from 5–25 m.

An additional 411 specimens from 180 museum lots were examined, representing all six valid species. Institutional abbreviations follow Leviton et al. (1985) with the addition of INPA (Instituto Nacional de Pesquisas da Amazônia, Manaus) and NRM (Swedish Museum of Natural History, Stockholm). Body sizes are all reported as total length in mm. Procedure for morphometrics follow Albert and Fink (1996) and are described with abbreviations in Figure 2 and Table 1. Measurements were taken from the left side of specimens and are included only for specimens with adult morphology (more

TABLE 1. MORPHOMETRIC DATA FOR ADULTS OF SEVEN SPECIES OF *Sternopygus*. See Figure 2 for abbreviations. TL, LEA, and HL expressed in millimeters. Percentage measurements in HL, or if marked with an asterisk, in LEA. *N*-values (in parentheses) vary because measurements were excluded from some specimens with damage (see text) or unusual preservation artifacts. NA, data not available. †, data from original published description.

Species	max TL	LEA	HL	%HL*	Mean	AFL%*	Mean
Sternopygus aequilabiatus	441 (17)	149–390 (17)	23.5–55.8 (17)	13.2–17.9 (17)	15.6	81.4–85.9 (17)	83.5
Sternopygus arenatus	560 (7)	142–455 (8)	19.6–62.2 (8)	13.2–20.4 (8)	14.9	67.9–95.0 (8)	82.8
Sternopygus astrabes	233 (17)	81–178 (17)	10.7–23.7 (17)	11.7–14.1 (17)	13.3	79.0–89.7 (17)	84.1
Sternopygus branco n. sp.	492 (16)	171–354 (13)	24.4–41.3 (13)	11.4–14.3 (13)	12.5	82.5–88.5 (13)	86.9
Sternopygus castroi†	178 (4)	NA	15.3–22.1 (4)	NA	NA	NA	NA
Sternopygus macrurus	525 (142)	101–455 (66)	15.2–63.0 (66)	12.5–18.4 (66)	14.7	73.5–96.4 (66)	84.3
Sternopygus xingu	460 (7)	162–446 (7)	26.3–75.6 (7)	16.1–19.6 (7)	16.9	80.9–87.0 (7)	83.2

Species	PR%	Mean	ED%	Mean	PO%	Mean	NN%	Mean
Sternopygus aequilabiatus	30.6–36.1 (17)	33.1	6.8–9.8 (17)	8.54	55.9–60.1 (17)	58.7	10.4–14.4 (17)	11.9
Sternopygus arenatus	32.7–37.5 (8)	35.2	7.4–13.8 (4)	10.8	54.1–59.1 (8)	57.1	22.0–23.0 (4)	22.6
Sternopygus astrabes	28.9–35.0 (17)	32.2	13.6–18.1	15.0	52.2–56.5 (17)	54.1	14.6–20.6 (17)	17.3
Sternopygus branco n. sp.	36.1–40.6 (13)	38.5	9.8–13.5	10.8	50.8–55.1 (13)	53.2	14.9–17.4 (13)	16.0
Sternopygus castroi†	33.9–36.1 (4)	34.7	13.1–15.8	14.3	52.5–55.7 (4)	54.8	NA	NA
Sternopygus macrurus	30.8–39.3 (66)	35.8	7.5–16.3	11.4	49.4–60.8 (66)	55.7	10.1–17.9 (66)	14.5
Sternopygus xingu	31.4–33.9 (7)	32.6	6.7–12.9 (7)	10.4	52.7–59.3 (7)	55.8	11.4–15.6 (7)	13.4

Species	IO%	Mean	MW%	Mean	HD%	Mean	HW%	Mean
Sternopygus aequilabiatus	14.4–21.7 (17)	18.1	11.2–16.9	13.5	57.7–67.7 (17)	61.4	35.6–44.9 (17)	38.6
Sternopygus arenatus	21.4–33.0 (4)	25.3	11.0–18.4	15.3	68.7–73.4 (4)	70.8	38.8–47.1 (4)	41.9
Sternopygus astrabes	23.3–30.4 (17)	26.6	13.0–16.2	14.4	68.7–79.1 (17)	72.6	39.3–51.9 (17)	45.9
Sternopygus branco n. sp.	22.2–25.7 (13)	24.3	12.3–13.9	13.0	57.8–69.6 (13)	64.9	36.1–43.4 (13)	40.0
Sternopygus castroi†	NA	NA	NA	NA	73.4–76.9 (4)	75.2	NA	NA
Sternopygus macrurus	17.6–31.7 (66)	25.6	12.0–21.4	16.9	64.5–80.2 (66)	71.5	33.5–55.5 (66)	45.8
Sternopygus xingu	16.7–22.4 (7)	19.8	17.1–19.8	18.5	65.3–75.7 (7)	69.1	38.8–47.3 (7)	44.3

Species	P1%	Mean	PA%	Mean	BD%*	Mean	BW%*	Mean
Sternopygus aequilabiatus	43.7–53.3 (17)	48.6	40.1–57.0	48.8	10.5–15.3 (3)	12.1	5.3–7.3 (17)	5.8
Sternopygus arenatus	40.0–57.1 (4)	47.5	29.4–67.0	50.9	12.0–13.3 (4)	12.4	5.1–5.9 (4)	5.5
Sternopygus astrabes	53.6–66.7 (17)	60.3	15.0–51.9	36.5	10.4–12.4 (17)	11.5	4.6–6.5 (17)	5.4
Sternopygus branco n. sp.	50.2–57.2 (13)	53.4	30.3–38.2	33.9	8.3–10.9 (13)	9.3	4.2–6.4 (13)	4.5
Sternopygus castroi†	NA	NA	NA	NA	NA	NA	NA	NA
Sternopygus macrurus	42.0–64.7 (64)	51.8	26.7–65.1	43.2	10.3–15.6 (66)	12.8	4.6–8.1 (66)	6.1
Sternopygus xingu	36.8–43.9 (7)	40.4	24.6–42.4	33.6	13.4–16.1 (7)	14.3	6.2–8.2 (7)	6.7

than 80 mm in *S. astrabes*, more than 100 mm LEA in other species). Measurements presented as a proportion of LEA (AFL, BD, BW, HL) are included only for specimens that were undamaged anterior to the end of the anal fin, even if subsequent regeneration had repaired part of the anal fin.

Meristics are abbreviated in Table 2 and follow Albert and Fink (1996) with the addition of lateral line scales (LLS) counted from posterior edge of opercle to end of caudal appendage; scales above lateral line (SAL) counted as number of rows in a vertical series from (and including) first scale row above pored lateral-line series to dorsal midline at a position three times head length from tip of snout; scales below lateral line (SBL) counted in vertical series below the lateral line (not including pored lateral line series) to base of anal-fin pterygiophores at same position as SAL; scales over anal-fin pterygiophores (SOP) counted in vertical series from base of anal-fin pterygiophores to base of anal fin at same position as SAL.

Osteological data were taken from specimens cleared and stained (c&s) with Alizarin red and Alcian blue using the enzyme technique of Dingerkus and Uhler (1977) with the reagent concentrations and reaction times adjusted according to specimen size. Standardized dissection methods of small teleosts were used following Weitzman (1962). Bone nomenclature and conventions for osteological illustrations follow Albert and Fink (1996). All drawings were made with the aid of an Olympus SZX12 dissecting microscope equipped with a camera lucida and edited with a PC graphics program.

EOD recording techniques follow Crampton (1998a). A full description of inter- and intraspecific electric organ discharge (EOD) waveform variation in all *Sternopygus* species from the Amazon basin will be published in a subsequent paper. Here summary data are presented only for the new species described herein. Specimens were recorded in water from the capture locality at temperatures between 27 and 29 C soon after capture. Field numbers for EOD-recorded fish follow a standard format: for example, WGRC 02.070201 (second specimen collected and recorded on 07 February 2001).

Diagnosis and Nomenclature of *Sternopygus*

Diagnosis.—Among gymnotiform fishes, species of *Sternopygus* can be unambiguously diagnosed by the following unique combination of features (modified from Albert, 2001): (1) maxilla long, without connective tissue on ventral border, anterior border of descending blade smooth and evenly curved; (2) anterior process of maxilla extends as a narrow hooklike process (Lundberg and Mago-Leccia, 1986); (3) dorsal portion of ventral ethmoid elongate; (4) posttemporal fossa between pterotic and epioccipital (Lundberg and Mago-Leccia, 1986); (5) gill rakers composed of three bony elements, the middle one with 3–10 small teeth (Mago-Leccia, 1978); (6) gill rakers, not attached to the branchial arches; (7) gap between parapophyses of second vertebra and *os suspensorium*; (8) postcleithrum not ossified (Albert and Fink, 1996); (9) body cavity long, with 18–30 precaudal vertebrae; (10) anal fin long, more than 220 rays (except in *S. astrabes*); (11) all anal-fin rays unbranched; (12) developmental origin of adult electric organ from both hypaxial and epaxial muscles (Unguez and Zakon, 1998); (13) absence of jamming avoidance response (JAR; Heiligenberg, 1991); (14) presence of a medial cephalic fold, a fleshy fold running from the ventral limit of the opercular opening to the isthmus region (Triques, 2000). The following three features previously used in the diagnosis of *Sternopygus* are not observed in the new species reported here: distinct rounded black humeral spot with sharp, high contrast margins; pale lateral stripe along anal-fin base.

Nomenclature.—Valid species of *Sternopygus* are listed below. Square brackets contain modern or corrected spellings for river or place names.

Sternopygus aequilabiatus (Humboldt, 1805)
- *Gymnotus aequilabiatus* Humboldt, in Humboldt and Bonpland, 1805:79, Pl. 10, fig. 1 (Río Magdalena, Colombia).
- *Sternopygus dariensis* Meek and Hildebrand, 1916:309, Pl. 26, fig. 21 (Marrigante, Río Tuyra, Panamá).

Sternopygus pejeraton Schultz, 1949:60–61, Pl. 1A (Río Apón, Maracaibo basin, Venezuela).

Sternopygus arenatus Eydoux and Souleyet, 1841: 143, Pl. 8, fig. 2 (Río Guayaquil, Ecuador).

Sternopygus astrabes Mago-Leccia, 1994:79–80, Pl. 87 (Caño Pozo Azul, Agua Linda, 23 km NE. Puerto Ayacucho, tributary of Río Orinoco, Amazonas, Venezuela).

Sternopygus branco new species.

Sternopygus castroi Triques, 2000:19–26, figs. 1–2 (Igarapé Jaradá, Rio Cueiras, tributary of Rio Negro, Brazil).

Sternopygus macrurus (Bloch and Schneider, 1801)
- *Gymnotus macrurus* Bloch and Schneider, 1801:522 (Brazil).
- *Sternopygus marcgravii* Reinhardt, 1852:146 (Rio das Velhas, Brazil).

TABLE 2. MERISTIC DATA FOR SEVEN SPECIES OF *Sternopygus*. Abbreviations: AFR, anal-fin rays; LLS, lateral-line scales; PCV, precaudal vertebrae; P1R, pectoral-fin rays; SAL, scales above lateral line; SBL, scales below lateral line; SOP, scales over pterygiophores. *N*-values in parentheses. Med., median value to nearest whole number. Values under mode marked with asterisk represent median. NA, data not available. †, data from original description.

Species	AFR	Med.	LLS	Med.	PCV	Mode	P1R	Mode
Sternopygus aequilabiatus	228–310 (16)	284	200–305 (18)	236	23–25 (16)	24	14–17 (20)	16*
Sternopygus arenatus	180–225 (5)	215	179–245 (5)	221	21–24 (6)	23	15–17 (9)	15
Sternopygus astrabes	170–298 (19)	200	185–235 (17)	224	18–19 (23)	19	15–17 (23)	16
Sternopygus branco n. sp.	250–340 (12)	309	280–340 (10)	299	25–27 (12)	26	12–15 (13)	13
Sternopygus castroi†	255–307 (4)	NA	NA	NA	NA	NA	16–17 (4)	NA
Sternopygus macrurus	195–300 (33)	261	178–330 (28)	220	24–28 (32)	26	13–17 (59)	15
Sternopygus xingu	292–321 (4)	312	155–205 (3)	192	28–29 (4)	29	12–15 (8)	12

Species	SAL	Med.	SBL	Med.	SOP	Med.
Sternopygus aequilabiatus	12–24 (18)	17	7–13 (18)	9	10–16 (18)	13
Sternopygus arenatus	15–16 (6)	16	7–9 (6)	8	15–16 (6)	16
Sternopygus astrabes	11–18 (19)	15	9–14 (19)	12	10–16 (19)	14
Sternopygus branco n. sp.	17–26 (10)	19	13–17 (10)	16	13–20 (10)	17
Sternopygus castroi†	NA	NA	NA	NA	NA	NA
Sternopygus macrurus	12–22 (28)	16	6–20 (28)	9	9–15 (28)	13
Sternopygus xingu	14–16 (3)	15	6–8 (3)	7	14–19 (3)	18

Carapus sanguinolentus Castelnau, 1855:85, 94, Pl. 46, fig. 1 (Río Urubamba, Upper Río Ucayali, Peru).

Sternopygus obtusirostris Steindachner, 1881: 143, Pl. 2, fig. 3 (Rio Amazonas [Solimões] at Teffé [Tefé], Lago Alexo [Aleixo] and Manacapouru [Manacapuru], Rio Puty [Poti], Rio Madeira).

Hildatia brasiliensis Fernández-Yépez, 1968: no pagination, fig. (unlabeled) (Sarapo, Piauhy [Piaui], Brazil).

Sternopygus xingu Albert and Fink, 1996:85–102, figs 7–9 (Rio Batovi, Mato Grosso do Sul, Brazil).

Sternopygus branco new species
Figures 3–7

Holotype.—MCP 32451 (WGRC 02.070201), 405 mm, Brazil, Amazonas, confluence of Rio Solimões (Amazonas) and Rio Japurá, Comunidade Caborini, Municipality of Alvarães, 03°09′08″S, 64°47′04″W, collected by W. Crampton, 7 February 2001 (Figs. 3–5).

Paratypes.—INPA 15786 (1) (WGRC 09.280199, female, 492 mm), Mamirauá lake system, Paraná Maiana, near confluence of Rio Solimões and Japurá, 03°06′44″S, 64°47′32″W, 28 January 1999. INPA 18236 (1) (WGRC 09.240200, 265 mm), same locality as holotype, 24 February 2000. MCP 32241 (1) (WGRC 12.080299, female, 429 mm), same locality as holotype, 8 February 1999. MCP 32242 (3) (WGRC 01.071299, 244 mm; WGRC 11.071299, c&s, 272 mm; WGRC 12.071299, c&s, 280 mm), Rio Japurá near confluence with Rio Solimões, 03°07′08″S, 64°47′20″W, 7 December 1999. MCP 32243 (1) (WGRC 12.120100, c&s, 332 mm), same locality as INPA 15786, 12 January 2000. MCP 32244 (1) (WGRC 07.220200, 328 mm), same locality as INPA 15786, 22 February 2000. MCP 32245 (2) (WGRC 01.240200, 314 mm; WGRC 06.240200, c&s, 330 mm), collected with INPA 18236. MCP 32246 (3) (WGRC 12.070201, female, 440 mm; WGRC 13.070201, 393 mm; WGRC 14.070201, 400 mm), collected with holotype. All paratypes collected by W. Crampton from Municipality of Alvarães, Amazonas, Brazil.

Nontypes.—INPA 12370 (1), 250 mm, Brazil, Amazonas, Rio Negro, Lago Prato, Municipality of Novo Airão, approx. 02°38′S, 60°57′W, coll. M Garcia, 18 September 1999. MZUSP 56187 (1) 421, Brazil, Amazonas, Rio Negro, Manaus, 03°03′S, 60°24′W, coll. J. Lundberg et al., 13 December 1993.

Diagnosis.—*Sternopygus branco* can be distinguished from all other *Sternopygus* in possessing the following unique characters: Very low EOD repetition rate, 24–35 Hz, versus approximately 40–300 Hz. Very pale body surface, versus dark or very dark pigmentation on body surface. Pale lateral stripe along dorsal margin of anal-fin pterygiophores absent, versus present in adults and or juveniles. Body slender, body depth 8.3–10.9% LEA versus 10.3–16.1. Posterior margin of cleithrum short, less than 50% its height, versus more than 50% height. Supracleithrum short and robust, versus long and slender. *Sternopygus branco* can be further distinguished from congeners in possessing the following unique combination of characters. Humeral spot very faint (sometimes absent), diffuse and vertically elongated, versus absent in *S. aequilabiatus*, *S. arenatus*, *S. astrabes*, and *S. castroi* and verses distinct and rounded or ovoid in *S. macrurus* and *S. xingu*. Head of adults distinctly cone-shaped with straight or slightly convex dorsal and ventral margins (Fig. 3) versus strongly concave or convex dorsal and/or ventral margins in all congeners except large specimens of *S. arenatus*. Preorbital distance long, 36.1–40.6% HL, versus 28.9–36.1% HL in all congeners except *S. arenatus* and *S. macrurus*. Many lateral line scales, 280–340, versus 155–280 in all congeners except *S. aequilabiatus* and *S. macrurus*. Thirteen to 17 scales below lateral line versus 6–13 in all congeners except *S. astrabes* and *S. macrurus*. Seventeen to 26 scales above lateral line versus 14–16 in *S. arenatus* and *S. xingu*. Twenty-five to 29 precaudal vertebrae versus 18–24 in *S. arenatus* and *S. astrabes*. Dark vertical bars on body surface never present versus present in *S. astrabes* and *S. castroi*. Neurocranium dorsoventrally compressed, mean neurocranium depth (measured from posterior dorsal tip of supraoccipital to posterior ventral margin of basioccipital) 33% of neurocranium length (measured from anterior tip of mesethmoid to posterior ventral margin of basioccipital), versus 36–37% in *S. arenatus*, *S. astrabes*, and *S. macrurus*. Margin of frontal convex, versus straight in *S. aequilabiatus*, *S. arenatus*, and *S. xingu*. Vomer short and broad, length less than five times width at midlength, versus long and narrow in *S. aequilabiatus*, *S. arenatus*, and *S. xingu*.

Description.—Head and body shape and pigmentation illustrated in Figure 3. Morphological and meristic data presented in Tables 1 and 2, respectively. Cephalic sensory canal pore configurations summarized in Figure 4. Size large, up to 492 mm TL (417 mm LEA) and 100g in life. Maturity attained at a minimum of 437 mm TL

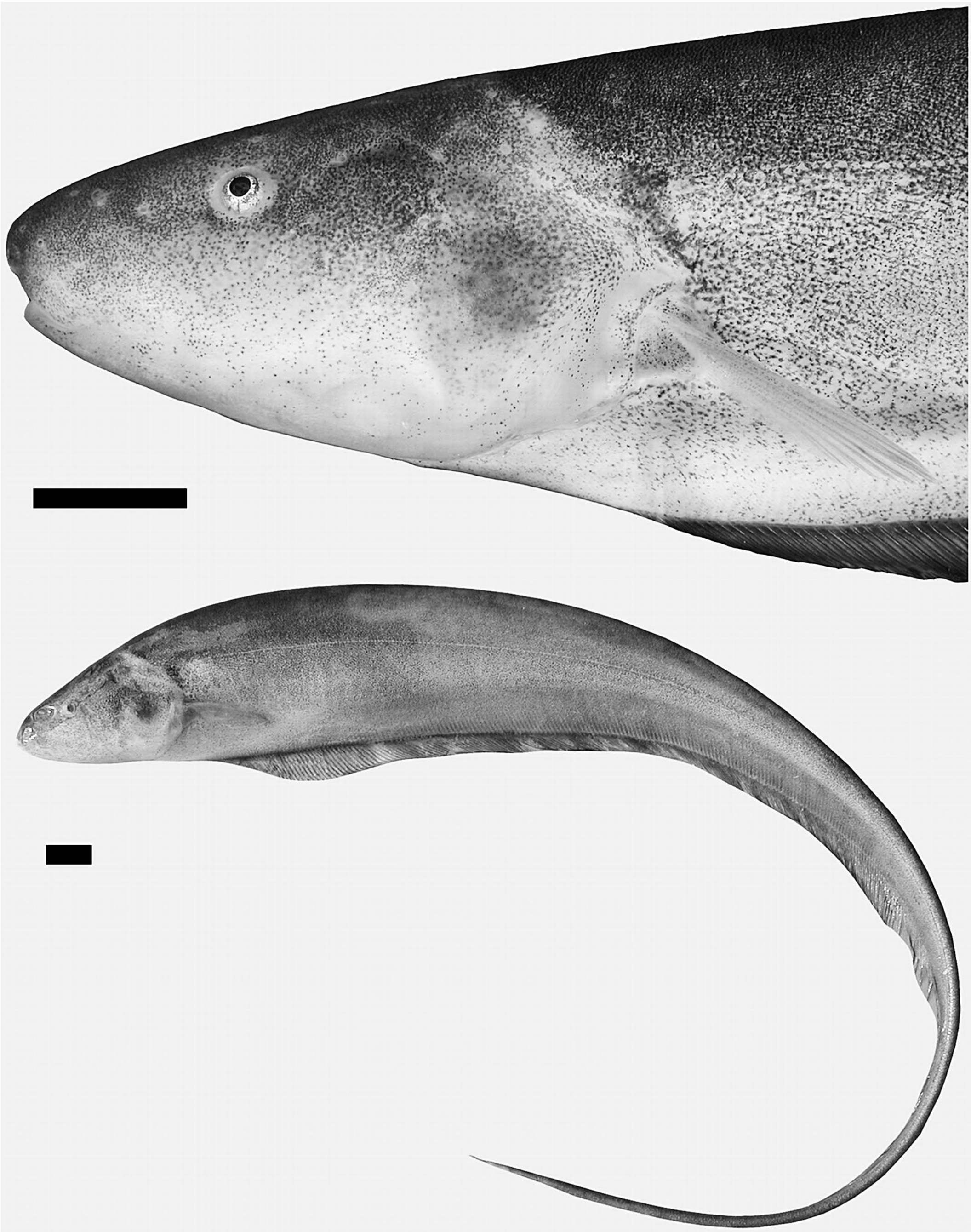

Fig. 3. Photograph of head of holotype of *Sternopygus branco* n. sp., MCP 32451 (WGRC 02.070201) and body of paratype MCP 32246 (WGRC 14.070201). Scale bars = 10 mm. Both photographs from live specimens.

(362 mm LEA) in females. Sexually mature males not known.

Body slender and strongly laterally compressed. Body uniformly covered with approximately circular cycloid scales. Head and fins naked. Lateral line complete. Dorsal and ventral profiles of the body approximately convex in region of body cavity. Posterior to body cavity: ventral profile of body approximately straight to end of anal fin; dorsal profile slightly convex to straight. Anal-fin origin at vertical with base of first pectoral-fin ray. Caudal filament elongate

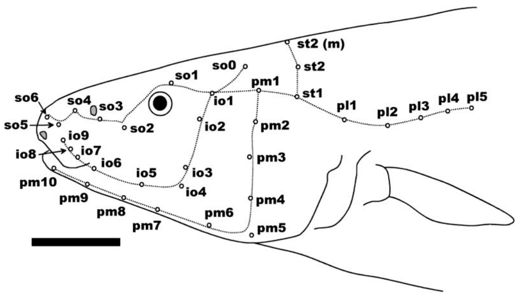

Fig. 4. Head of the holotype of *Sternopygus branco* n. sp. illustrating organization of cephalic sensory canals and pores. Centerline of canals (ossified and unossified) indicated by dashed lines. Pores indicated by small circles. Eye and anterior and posterior nares shaded gray. Abbreviations: SO, supraorbital; IO, infraorbital; PL, posterior lateral-line; PM, preopercular-mandibular; ST, supratemporal; M, medial. Scale bar = 10 mm.

and cylindrical. Anal fin long with 250–340 (median 309, $n = 12$) unbranched rays. Pectoral fin with 12–15 (mode 13, $n = 12$) rays. Dorsal, ventral and caudal fins absent. Hypaxial electric organ extending along entire pelvic margin of body and caudal appendage.

Head cone-shaped. Dorsal profile of head straight or slightly convex, strongly convex only at snout. Ventral profile of head straight. Mouth terminal or slightly subterminal. Gape horizontal when viewed head-on. Corner of mouth forming a strong curve or obtuse angle around ventral margin of maxilla in lateral view, rictus at vertical with posterior nares. Anterior and posterior nares present, not tubular. Anterior nares at one narial pore width from tip of snout. Posterior nares 2.5 eye diameters from anterior margin of eye. Eyes lateral, dorsally positioned,

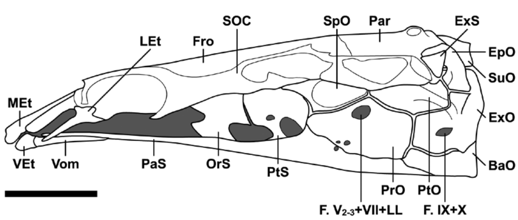

Fig. 5. Lateral view of the neurocranium of *Sternopygus branco* n. sp. Gray indicates foramina or absence of bone. Abbreviations: MEt, mesethmoid; LEt, lateral ethmoid; Fro, frontal; SOC supraorbital canal bone; SpO, sphenotic; Par, parietal; Exs, extrascapular; EpO, epioccipital; SuO, supraoccipital; ExO, exoccipital; BaO, basioccipital; VEt, ventral ethmoid; Vom, vomer; PaS, parasphenoid; OrS, orbitosphenoid; PtS, pterosphenoid; PrO, prootic; PtO, pterotic; F, foramina for cranial nerves (V2–3. VII, IX, X) and lateral line nerves (LL). Scale bar = 5 mm.

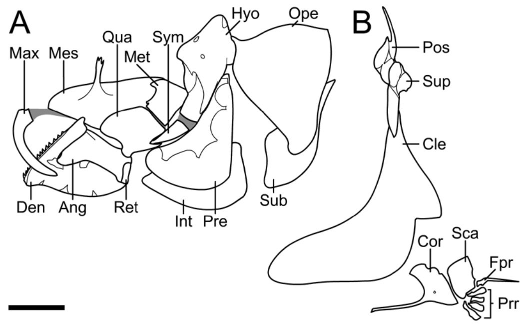

Fig. 6. Lateral view of the suspensorium and pectoral girdle of *Sternopygus branco* n. sp. Gray indicates cartilage. Abbreviations: Mes, mesopterygoid; Met, metapterygoid; Hyo, hyomandibula; Ope, opercle; Max, maxilla; Den, dentary; Ang, anguloarticular; Ret, retroarticular; Qua, quadrate; Sym, symplectic; Int, interopercle; Pre, preopercle; Sub, subopercle; Pos, posttemporal; Sup, supracleithrum; Cle, cleithrum; Cor, coracoid; Sca, scapula; Fpr, first pectoral ray; Prr, proximal radials. Scale bar = 5 mm.

ventral margin of eye above horizontal with tip of snout. Eyes with free orbital margin.

Neurocranium (Fig. 5): Mesethmoid robust. Dorsal portion of ventral ethmoid elongate.

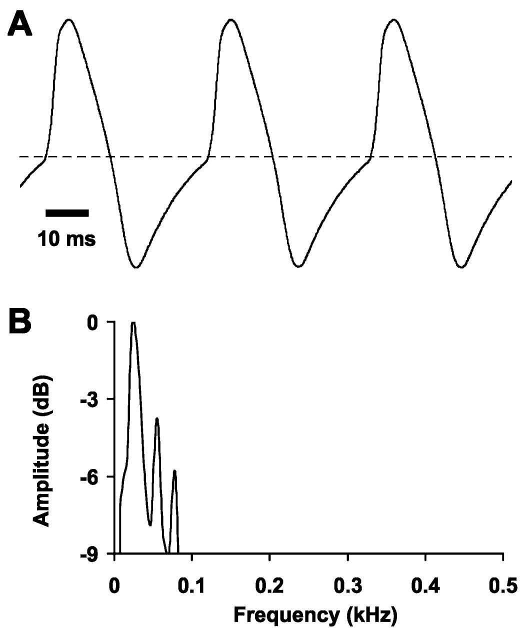

Fig. 7. Electric Organ Discharge (EOD) waveform (A) and Fourier Power Spectrum (B) of holotype of *Sternopygus branco* n. sp. EOD plotted with head-positive upwards. The Power Spectrum was computed from a 2048 point Fast-Fourier-Transform and the Peak-Power-Frequency scaled to the minimum attenuation of 0 dB.

Ethmoid region well ossified. Lateral ethmoid cartilage contacting maxilla. Lateral ethmoid independently ossified (not coossified with frontal). Lateral ethmoid process long, extending lateral to dorsal margin of vomer. Antorbital process of frontal present. Sphenotic spine absent. Ventral margin of anterior portion of parasphenoid straight in adults. Posttemporal fossa present between pterotic and epioccipital. Infraorbitals 3 and 4 form large partial cylinders with slender bony arches. Gap between parapophyses of second vertebra and *os suspensorium.*

Jaws, suspensorium, and pectoral girdle (Fig. 6): Dentary with about 50 small conical teeth, recurved on anterior portion and curved medially on posterior portion, arranged in 4–5 irregular rows with 24 teeth arranged along the outer margin. Premaxilla gracile, triangular in dorsal view, with about 50 long and needle-shaped teeth arranged irregularly in a brushlike manner. Maxilla long, without shelf of unossified connective tissue on ventral border, as wide at midlength as at broadest area near palatine articulation, anterior process narrow and hooklike. Retroarticular anterior process not ossified. Anguloarticular ascending process elongate, extending to dorsal margin of anguloarticular. Mesopterygoid with 18–20 small and conical teeth, robust, firmly attached to sphenotic of neurocranium by ligament. Hyomandibular lateral ridge long, extending close to ventral margin of hymomandibular. Posterior margin of opercle straight, incompletely ossified. Scapular foramen absent. Postcleithrum not ossified. Posttemporal not fused with cleithrum. Posterior margin of cleithrum long, more than 50% of height. Supracleithrum short and robust.

Branchial basket: Six gill arches. Gill rakers not attached to branchial arches. Each raker formed from three separate ossifications, with 1–8 (mode 3) very small teeth on the central ossification. Nine rakers on first gill arch; 6–7 rakers on ceratobranchial of first gill arch; 18–20 rakers on third gill arch, seven teeth on enlarged bony plate of ceratobranchial on sixth (posterior) gill arch.

Color in life.—Ground color of freshly netted specimens uniformly white speckled with pinkish brown chromatophores. Chromatophore density increases dorsally on body and head surface. Few to no chromatophores on ventral surface of head, isthmus and ventral midline anterior to first anal-fin ray. No banding or dark blotches, no pale lateral stripe along dorsal margin of anal-fin pterygiophores. Faint and diffuse charcoal-colored humeral spot present or absent, when present vertically elongate, about two eye diameters in width, positioned mostly below lateral line. Anal and pectoral-fin membranes hyaline. Anal and pectoral fin-rays with sparse distribution of dark chromatophores. Within moments of capture specimens become slightly darker (but never as dark as congeners) caused by expansion of chromatophores, especially dorsally. Specimens also develop a pinkish hue over body surface, especially over pterygiophores, caused by hemorrhaging of capillaries. Live specimens become noticeably paler during the night, caused by contraction of chromatophores.

Color in ethanol.—Ground color of body uniformly tan, slightly counter shaded, darker dorsally with light speckling of brown chromatophores over entire body and no banding, blotches, or pale lateral stripe along dorsal margin of anal-fin pterygiophores. Humeral spot as in life. Lateral line canal tubes and pores not pigmented such that lateral line appears as fine whitish line. Anal and pectoral-fin membranes hyaline. Anal and pectoral fin-rays with sparse distribution of dark chromatophores. Head strongly counter shaded, pale yellow ventrally to tan dorsally, without chromatophores on ventral midline. All fins with translucent membranes and hyaline rays.

Electric organ discharges.—*Sternopygus branco* generates a continuous wave (tone)-type discharge EOD with a stable frequency (cycle rate) of 24–35 Hz (mean 30.6, standard deviation 3.2, n = 14 specimens). The EOD waveform of *S. branco* (Fig. 7A) is sinusoid-like with an inflection in the rate of voltage change just below the zero volt baseline. The EOD repetition rate of *S. branco* remains constant throughout the day and night and is lower than all other congeners with documented EODs (approximately 40–300 Hz) (Crampton, 1998a; pers. obs.), and lower than all known species of gymnotiforms with wave-type EODs (families Sternopygidae and Apteronotidae). The EOD of *S. branco* has a harmonic spectral energy content (Fig. 7B), with spectral energy concentrated into the fundamental frequency of the discharge (equivalent to the repetition rate) and decreasing amounts of energy in integer multiples (higher harmonics) of the fundamental frequency. No sexually mature males were recorded in *S. branco*; therefore sexual differences in EOD remain undocumented in this species. *Sternopygus macrurus* has a sexual difference in EOD frequency, with males generally having around half the EOD frequency of females (Hopkins, 1972, 1974). A forthcoming paper will discuss EOD signal dif-

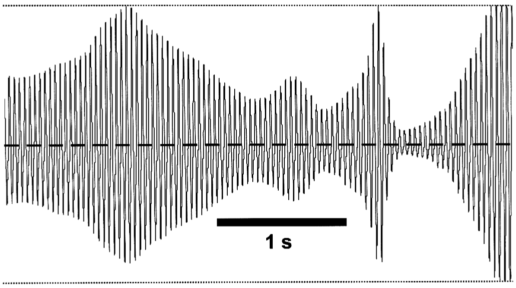

Fig. 8. Electric Organ Discharge (EOD) waveform of holotype of *Sternopygus branco* n. sp. showing spontaneous changes in amplitude of discharge. The central dashed line represents 0 V. The EOD is truncated by amplifier overload at the dotted lines.

ferences between sympatric species of *Sternopygus* in the Amazon basin.

Sternopygus branco is able to modulate its EOD amplitude rapidly and without appreciable movement of the body. Specimens were constrained within a cage that prohibited backward and forward or lateral movement to eliminate EOD amplitude modulations caused by movement of the fish's electric organ relative to the recording electrode. Spontaneous EOD modulations involving up to a 10-fold increase or decrease in amplitude were observed to occur within a one-second interval (Fig. 8). Similar, but less pronounced, amplitude modulations were observed in *S. macrurus* but not in *S. astrabes.* Amplitude modulations have been studied in *S. macrurus*, and a mechanistic hypothesis for this phenomenon advanced (McAnelly et al. 2003).

Ecology.—*Sternopygus branco* occurs in the main channels of major rivers or their side branches. It is not known to occur in seasonally inundated floodplain forests or in forest streams of the Amazon's terra firme. *Sternopygus branco* is known from both high-conductivity (50–250 μScm^{-1}), sediment-laden whitewater rivers such as the Amazon river and low-conductivity (5–25 μScm^{-1}), sediment poor blackwater rivers such as the Rio Negro. Dissolved oxygen levels in these rivers are always relatively high, in the range 3–6 mg/L, and temperatures are typically similar from the surface to the bottom, in the range 29–32 C. In the Tefé region, *S. branco* was captured with beach seines and trawl nets at depth of up to 10 m in areas with weak currents, such as in large eddies, sheltered bays or ''paranás'' (side-branches of the main river channels that wind their way through the whitewater ''várzea'' floodplain). In the Tefé region *S. branco* occurs syntopically with *S. macrurus* in whitewater habitats. *Sternopygus branco* never occurs syntopically with *S. astrabes*, a small species which is confined to terra firme forest streams.

Surveys with submerged electrodes reveal that *S. branco* never occurs where currents near the substrate exceeded 0.1 m/sec. During the day, this species is usually encountered near submerged structures such as fallen trees and driftwood. During the night, *S. branco* moves into shallower water and away from structures. Specimens were captured on both sand and mud bottoms. Electrode surveys and the sporadic occurrence of *S. branco* in nets indicate that this species does not live in groups. Sexually mature males were never encountered, but gravid females were found along the edge of whitewater floodplain areas and in paraná channels during the rising water months of January and February. Most gymnotiforms spawn during the rising water phase of the annual flood cycle (Crampton, 1996b) when large areas of low-lying land become inundated in the whitewater floodplain.

Dietary preferences of *S. branco* were characterized from the dissection of stomach contents from a few specimens captured in the Tefé area and are summarized in Table 3. This species feeds predominantly on autochthonous insect larvae, which it encounters in the substrate. The presence of small pieces of wood in many of the stomachs indicate that *S. branco* forages among organic detritus on the river bed rather than within rafts of floating meadows or marginal macrophytes. One specimen had ingested a chunk of sponge from the benthic genus *Drulia.*

Distribution.—*Sternopygus branco* is known only from the main channel of the Amazon River between its confluences with the Rios Japurá and Negro and from the lower 100 km of the main channel of the Rio Negro (Fig. 9).

Etymology.—The specific epithet is from the Portuguese for white, branco, referring to the characteristic pale color of freshly netted live specimens. A noun in apposition. Fishers of the Tefé region of Brazil call this species ''sarapó branco.'' Sarapó is a word of Tupi-Guarani origin used for many gymnotiform fishes in the Brazilian Amazon.

Materials Examined

Data are arranged by country, state, then alphabetically by museum acronym and number. Catalog numbers are followed in parentheses by number of specimens, size range in mm TL,

TABLE 3. PROPORTIONAL COMPOSITION OF FOOD ITEMS IN STOMACHS OF 10 SPECIMENS OF *Sternopygus branco* N. SP. Specimens from the main river channel and "paraná" side branches of the Amazon River near Tefé, Amazonas, Brazil.

	Specimen										
	1	2	3	4	5	6	7	8	9	10	Mean%
Estimated % fullness	75	100	100	50	100	100	15	10	100	75	73
% Food item:											
Chironomidae (larvae)			20	10		20	80	40	10		18
Coleoptera (larvae)		15	10	10		10		10			5.5
Diptera (larvae)		10								20	3
Trichoptera (larvae)	75		50		70	60	20			60	33.5
Insect larvae (indet.)	20										2
Shrimps		75									7.5
Sponge (*Drulia* sp.)									90		9
Detritus—wood	5		15	80	5	10	10	10		20	15.5
Detritus–other			5		25						3

type-status, summary locality, geographical coordinates, and date of capture.

Sternopygus aequilabiatus.—Colombia: Antioquia: NRM 27742 (1, 385), Río Atrato, Buchadó, 06°25′N, 77°46′W, 1989.I.28. NRM 27745 (1, 441), Río Atrato, Buchadó, 06°25′N, 74°46′W, 1989. I. 27. Chocó: NRM 27746 (6, 271–348), Río Baudó, Boca de Pepé, 05°04′N, 77°03′W, 1989.II.22. Panama: Cocle: UF 27523 (5, 108–272), near El Valle, 08°31′N, 80°33′W, 1965.IV.24. Darien: UF 15451 (2, 350–415), Río Pirri, El Real, 08°07′59″N, 77°43′W, 1967.VI. Cocle: UF 27523 (5, 108–272), near El Valle, 08°31′N, 80°33′W, 1965.IV.24. Herrera: UF 12978 (2, 247–264), near Chepo, 07°43′59″N, 80°48′W, 1965.IV.29. Venezuela: Zulia: MCZ 37222 (1, paratype), Río Motatan, 09°28′N, 70°37′W, 1942.III.17. UF 25447 (1, 187), Río Catatumbo, 09°22′59″ N, 71°43′W, 1974.VI.17. UMMZ 157671 (2, 194–225, paratype), Río Palmar, 10°11′N, 71°52′W, 1942.II.21.

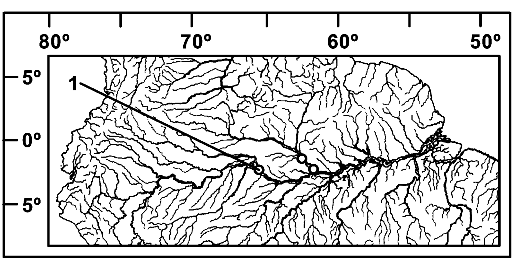

Fig. 9. Part of Northern South America showing collection records of *Sternopygus branco* n. sp. 1 = holotype locality. Some symbols represent more than one locality. Base map by M. Weitzman.

Sternopygus arenatus.—Ecuador: Esmeraldas: MCZ 54969 (4, 74–172), Río Cayapas, 00°44′ N, 78°55′W, 1977.VI.29. MCZ 58604 (1, 275), Río Cayapas, 01°44′ N, 77°55′W, 1977.VI.29. Guayas: UMMZ 205390 (4, 188–560), Guayaquil, 02°10′ S, 79°54′ W. Los Rios: MCZ 48804 (1, 440), Quevedo, 00°59′S, 79°27′W, 1971.XI.04.

Sternopygus astrabes.—Brazil: Amazonas: INPA 09980 (2, 134–165), Rio Demini, 00°23′18″S, 62°51′55″W, 2000.X.29. INPA 9981 (1, 166), Lago Amanã, 2°38′47″S, 64°39′19″W, 1995.I.5. MCP 32230 (1, 145), Rio Tefé, Tefé, 03°24′28″S, 64°44′10″W, 1998.XII.30. MCP 32231 (2, 72–77), Rio Tefé, Tefé, 03°24′28″S, 64°44′10″W, 1999.VIII.24. MCP 32232 (1, 93), Rio Tefé, Tefé, 03°24′28″S, 64°44′10″W, 1999.IX.21. MCP 32233 (1, 106), Rio Tefé, Tefé, 03°24′28″S, 64°44′16″W, 2000.III.17. MCP 32234 (1, 116), Rio Tefé, Tefé, 03°24′28″S, 64°44′10″W, 2000.X.10. MCP 32235 (10, 118–153), Rio Demini, 00°23′18″S, 62°51′55″W, 2000.X.29. MCP 32236 (4, 107–130), Rio Tefé, Tefé, 03°24′28″S, 64°44′10″W, 2002.X.16. MCP 32237 (1, 134), Rio Solimões, Alvarães, 03°16′05″S, 64°47′42″W, 2002.XI.27. MCP 32238 (1, 95), Rio Tefé, Tefé, 03°24′28″S, 64°44′10″W, 2003.I.24. MCP 32239 (2, 104–108), Rio Tefé, Tefé, 03°24′28″S, 64°44′10″W, 2003.II.20. MCP 32240 (2, 113–134), Rio Tefé, Tefé, 03°24′28″S, 64°44′10″W, 2003.II.26. Venezula: Amazonas: ANSP 162128 (1, 104, paratype), Río Orinoco, near Isla Temblador, 03°04′N, 66°28′W, 1987.III.10. ANSP 162663 (4, 89–233), Río Autana, Raudal Peresa, 04°46′N, 67°19′W, 1985.XI.13. Bolivar: AMNH 58643 (2, 263–267, paratype), Río Caura, 1985.XI.22.

Sternopygus castroi.—Brazil: Amazonas: MZUSP 47987 (1, 130, paratype), Rio Cueiras, Igarapé Sirinau, 02°70′S, 60°40′W, 1977.I.30. MZUSP 48911 (1, 117, paratype), Rio Cuieras, Igarapé Jaradá, 02°40′S, 60°20′W, 1977.II.01.

Sternopygus macrurus.—Argentina: La Plata: ANSP 78191 (1), Río de la Plata, 34°55′S, 57°57′W, approximately 1870s. Santiago del Estero: USNM 246086 (1), Río Dulce, 27°47′S, 64°16′W, 1933.VI.12. Bolivia: Beni: AMNH 39822 (1), Río Mamoré, Costa Marquez, 12°33′S, 64°12′W, 1964.X.9. AMNH 40159 (1), Río Mamoré, Guayaramerin, 10°51′S, 65°21′W, 1964.X.20. UMMZ 204744 (19, 124–427), Río Marmore, Río Itenez, 12°31′S, 64°19′W, 1964.IX.30. UMMZ 204800 (2, 320–322), Río Mamoré, Río Baures, 12°34′S, 64°19′W, 1964.X.3. USNM 305511 (1), Río Mamoré, Río Matos, 14°55′S, 66°17′W, 1987.VIII.28. Pando: FMNH 106700 (1), Río Mamoré, Cobija, 11°26′S, 69°01′W, 1996.IX.4. Santa Cruz Dept: UF 82344 (1), Río Mamoré, Río Jorge, 17°31′S, 63°15′W, 1986.VIII.10. Brazil: Amazonas: BMNH 1998.3.11.02 (1, 212), Rio Solimões, near Alvarães, 03°06′17″S, 64°55′07″W, 2003.VIII.29. BMNH 1998.3.11.03 (1, 145), Rio Solimões, near Alvarães, 03°06′17″S, 64°55′07″W, 2003. VIII.29. BMNH 1998.3.11.04 (1, 150), Rio Solimões, near Alvarães, 03°06′17″S, 64°55′07″W, 2003.VIII.29. BMNH 1998.3.11.05 (1, 157), Rio Solimões, near Alvarães, 03°06′17″S, 64°55′07″W, 2003.VIII.29. BMNH 1998.3.11.06 (1, 161), Rio Solimões-Japurá confluence, 02°54′46″S, 64°54′26″W, 1993.IX.16. BMNH 1998.3.11.07 (1, 163), Rio Solimões, near Tefé, 03°16′05″S, 64°41′21″W, 1993.IX.05. BMNH 1998.3.11.10 (1, 257), Lago Tefé, 03°20′08″S, 64°42′10″W, 1996.VII.27. BMNH 1998.3.11.11 (1, 210), Lago Tefé, 03°20′08″S, 64°42′10″W, 1996.VII.27. BMNH 1998.3.11.12 (1, 187), Lago Tefé, 03°20′08″S, 64°42′10″W, 1996.VII.27. BMNH 1998.3.11.13 (1, 43), Rio Tefé, Igarapé Curupira, 03°26′01″S, 64°43′47″W, 1995.II.04. INPA 15783 (1, 418), Lago Amanã, 02°28′54″S, 64°42′48″W, 1998.XI.30. INPA 15802 (2, 286–305), Rio Solimões-Japurá confluence, 03°07′08″S, 64°47′18″W, 1999.X.15. INPA 17143 (2, 207–242), Rio Purus, Lago Jari, 04°54′51″S, 62°21′26″W, 2001.VI.08. INPA 17305 (1, 190), Rio Purus, Sacado de Santa Luzia, 04°42′18″S, 62°22′26″W, 2001.VI.04. INPA 18165 (1, 204), Rio Solimões-Japurá confluence, 03°09′08″S, 64°47′04″W, 1999.XII.08. INPA 18166 (3, 172–221), Rio Japurá, Paraná Maiana, 03°04′50″S, 64°47′18″W, 1999.X.15. INPA 18188 (3, 232–283), Lago Tefé, 03°34′35″S, 64°59′19″W, 1999.VI.22. INPA 18190 (4, 360–492), Rio Japurá, Paraná Maiana, 03°04′50″S, 64°47′18″W, 1999.I.13. INPA 18233 (1, 252), Rio Tefé, 03°46′49″S, 64°59′29″W, 2000.VI.01. INPA 18234 (1, 168), Rio Solimões-Japurá confluence, 03°09′08″S, 64°47′04″W, 1999.XII.08. INPA 18235 (1, 220), Rio Solimões-Japurá confluence, 03°09′08″S, 64°47′04″W, 2000.II.24. INPA 18238 (1, 88), Lago Caiambé, 03°35′34″S, 64°26′37″W, 1998.XII.28. INPA 18316 (1, 345), Rio Japurá, Paraná Maiana, 03°06′44″S, 64°47′32″W, 1999.XII.05. INPA 18317 (1, 48), Rio Tefé, Igarapé Curupira, 03°26′01″S, 64°43′47″W, 2000.II.07. INPA 4736 (3, 94–147), Rio Solimões, Lago Janauacá, 03°25′28″S, 60°16′53″W, 1978.III.17. INPA 4809 (2, 212–357), Rio Solimões, Lago Janauacá, 03°25′28″S, 60°16′53″W, 1978.IV.07. INPA 4824 (1, 450), Rio Solimões, Ilha do Careiro, 03°12′S, 59°45′W, 1985.XII.02. INPA 4837 (1, 310), Rio Uatamã, Balbina, 01°53′S, 59°28′W, 1987.X.24. INPA 4841 (1, 325), Rio Solimões, Ilha do Careiro, 03°12′S, 59°45′W, 1985.XI.18. INPA 4869 (6, 33–130), Rio Solimões, Lago Janauacá, 03°25′28″S, 60°15′53″W, 1978.II.25. INPA 6428 (1, 165), Rio Solimões, Aramacá, 04°20′S, 69°55′W. INPA 6429 (2, 305–383), Rio Japurá, 1976.IX.30. INPA 6432 (3, 377–489), Rio Solimões, Ilha do Careiro, 03°12′S, 59°45′W, 1986.II.26. INPA 6433 (1, 443), Rio Solimões, Ilha do Careiro, 03°12′S, 59°45′W, 1987.III.31. INPA 9933 (1, 287), Rio Jaú, Miracutucu, 01°54′S, 61°26′W, 1994.X.29. Pará: INPA uncat. (6, 236–433), Rio Jarim, Cachoeira Santo Antonio, 01°09′S, 51°54′W, 1987.VI.9–18. INPA uncat. (6, 236–433), Rio Jarim, Cachoeira Santo Antonio, 01°09′S, 51°54′W, 1987.VI.9–18. Amazonas: MCP 32247 (1, 107), Rio Solimões, near Alvarães, 03°06′18″S, 64°55′07″W, 2003.VIII.29. MCP 32248 (2, 150–185), Rio Japurá, Nova Colômbia, 02°54′47″S, 64°54′26″W, 1993.IX.16. MCP 32249 (8, 70–119), Lago Caiambé, 03°35′34″S, 64°26′37″W, 1998.XII.28. MCP 32250 (1, 197), Rio Solimões-Japurá confluence, 03°07′08″S, 64°47′18″W, 1999.I.19. MCP 32251 (3, 50–143), Rio Solimões-Japurá confluence, 03°06′44″S, 64°47′32″W, 1999.I.26. MCP 32252 (1, 202), Lago Tefé, 03°34′35″S, 64°59′19″W, 1999.VI.22. MCP 32253 (4, 235–350), Lago Tefé, 03°34′35″S, 64°59′19″W, 1999.VI.22. MCP 32254 (3, 168–375), Rio Tefé, 03°46′49″S, 64°59′29″W, 1999.VII.13. MCP 32255 (1, 113), Rio Tefé, Igarapé Repartimento, 03°24′28″S, 64°44′10″W, 1999.VII.29. MCP 32256 (1, 211), Rio Tefé, 03°47′19″S, 64°59′55″W, 1999.X.22. MCP 32257 (1, 118), Rio Tefé, Tefé, 03°24′28″S, 64°44′10″W, 1999.XII.22. MCP 32258 (1, 264), Rio Solimões-Japurá confluence, 03°09′08″S, 64°47′04″W, 2001.II.07. MCP uncat. (1, 196), Rio Solimões, Tefé, 03°46′S, 73°15′W. Bahia: MCP 16730 (1, 388), Rio Tato, near Barra de Cocos, 14°14′22″S, 44°31′42″W, 1993.VII.16. Ceará: MCZ 9418 (1, 430), Ceará, near Fortaleza, 1865.VIII.05. Goiás: MCP 18204 (1, 400), Rio Araguia, near Lúis Alves, 13°14′S, 50°35′W. MNRJ 12189 (2, 37–146), Rio Maranhão, Rio da Mula, 14°16′S, 49°04′W, 1985.VII.10. MNRJ 12190 (2, 128–135), Rio Tocantins, Serra da Mesa, 14°50′S, 48°19′W, 1985.X.20. MNRJ 12191 (10, 137–365), Rio Tocantins, Córrego Barriguda, 14°05′S, 48°20′W, 1985.X.15. MNRJ 12208 (2, 100–211), Rio Tocantins, Córrego Lajeado, 13°31′S, 49°10′W, 1987.V.29. MNRJ 12209 (4, 118–136), Rio Tocantins, Córrego Lajeado, 13°39′S, 48°09′W, 1987.I.06. Mato Grosso: INPA 11578 (1, 112), Rio Aripuanã, Dardanelos, 09°10′S, 60°38′W, 1976.XI.09. Minas Gerais: ANSP 172171 (2, 60–277), Rio Verde Grande, near Janauba, 16°39′01″S, 43°42′49″W, 1993.VII.20. Pará: INPA 4843 (12, 114–220), Rio Tocantins, Tucuruí, 04°25′S, 49°32′W, 1984.XII.01. INPA 5739 (1, 162), Rio Trombetas, Rio Cachorro, 00°58′S, 57°02′59″W, 1988.XII.08. INPA 6409 (1, 256), Rio Tocantins, Breu Branco, 04°01′59″S, 49°40′W, 1981.XI.14. INPA 6410 (1, 382), Rio Tocantins, Igarapé Jatobal, 08°56′S, 49°46′W, 1980.X.31. INPA 6411 (2, 234–317), Rio Tocantins, Breu Branco, 04°04′04″S, 49°38′08″W, 1982.VII.13. INPA 6414 (2, 118–220), Rio Tocantins, Igarapé Jatobal, 08°56′S, 49°46′W, 1982.VII.08. INPA 6416 (1, 425), Rio Tocantins, Tucuruí, 03°42′S, 49°42′W, 1980.X.26. INPA 6431 (3, 366–495), Rio Tocantins, Tucuruí, 03°42′S, 49°42′W, 1985.XXXI.31. INPA 9092 (2, 225–271), Rio Tocantins, Laguinho, 08°56′S, 49°46′W, 1981.XI.11. INPA uncat. (6, 236–433), Rio Jarim, Cachoeira Santo Antonio, 01°09′S, 51°54′W, 1987.VI.9–18. INPA uncat. (6, 236–433), Rio Jarim, Cachoeira Santo Antonio, 01°09′S, 51°54′W, 1987.VI.9–18. MCZ 9409 (1, 385), Ilha do Marajó, Lago Arari, 00°20′S, 49°10′W, 1866.III.01. MCZ 9412 (2, 250–485), Rio Pará, near Belém, 01°27′S, 48°29′W, 1865.VIII.10. MCZ 9442 (2, 443–460), Rio Pará, near Belém, 01°27′S, 48°29′W, 1865.VIII.10. MCZ 9456 (5, 382–442), Rio Pará, near Belém, 01°27′S, 48°29′W, 1865.VIII.10. MCZ 9829 (2, 220–451), Rio Xingu, Porto de Moz, 01°45′S, 52°10′W, 1865.IX. MCZ 25708 (1, 369), Rio Xingu, Porto de Moz, 01°45′S, 52°10′W, 1865.IX. MCZ 45193 (6, 141–308), Ilha do Marajó, Cachoeira do Arari, 01°11′S, 48°45′W, 1965.VII. MCZ 60047 (1, 175), Rio Xingu, Porto de Moz, 01°45′S, 52°10′W, 1865.VIII.23. Piaui: AUM 20601 (1), Rio Parnaiba, Rio Gurgueia, 06°14′S, 42°37′W, 1971.IX.5. AUM 20630 (1), Rio Parnaiba, Rio Esfolado, 07°24′S, 43°38′W, 1971.IX.5. AUM 20757 (9), Rio Parnaiba, Santa Filomena, 09°08′S, 45°55′W, 1971.IX.8. MCZ 46859 (1, 171), Rio Parnaiba, Lagoa Seca, 03°11′S, 41°50′W, 1968.VIII.29. MCZ 9450 (3, 263–400), Rio Parnaiba, Rio Poti, 05°05′S, 42°49′W, 1865.XII. Rio de Janeiro: MCZ 45096 (1, 246), Rio Paraiba do Sul, near Rio de Janeiro, 22°53′S, 43°17′W, 1872.II. Rondônia: INPA uncat. (polo. 1206) (2, 175–390), Rio Machado, Nazaré, 10°05′S, 62°18′W, 1987.III.21. INPA uncat. (polo. 1353) (4, 119–205), Rio Jamari, UHE Samuel, 08°45′S, 63°28′W, 1988.VI.07. INPA uncat. (polo. 146) (6, 164–330), Rio Machado, Rio Urupá, 10°52′S, 61°58′W, 1984.VI.04. INPA uncat (polo. 204) (1, 420), Rio Guaporé, Surpresa, 11°54′S, 64°59′W, 1984.VI.16. INPA uncat. (polo. 610) (1, 155), Rio Machado, Nazaré, 10°05′S, 62°18′W, 1983.XI.09. INPA uncat. (polo. 629) (4, 170–290), Rio Machado, Jiparaná, 08°03′S, 62°52′W, 1984.VI.16. INPA uncat. (polo. 709) (2, 137–150), Rio Marmoré, Guajará-Mirim, 10°48′S, 65°22′W, 1983.XI.26. INPA uncat. (polo. 754) (15, 135–155), Rio Machado, Rio Urupá, 10°52′S, 61°58′W, 1984.VI.05. INPA uncat. (polo. 867) (1, 142), Rio Jamari, UHE Samuel, 08°45′S, 63°28′W, 1985.IX.04. INPA uncat. (polo. 949) (8, 131–286), Rio Jamari, UHE Samuel, 08°45′S, 63°28′W, 1985.IX.10. Roraima: INPA 1156 (1, 76), Rio Branco, Boa Vista, 02°49′N, 60°40′W. INPA 2046 (8, 129–525), Rio Uraricoera, Ilha Maracá, 03°02′N, 60°30′W, 1988.III.12. INPA 2060 (1, 221), Rio Uraricoera, Ilha Maracá, 03°02′N, 602°30′W, 1988.III.13. INPA 2062 (10, 70–395), Rio Uraricoera, Ilha Maracá, 03°02′N, 60°30′W, 1988.III.14. INPA 4540 (1, 159), Rio Mucajai, Cachoeira Paredão, 02°25′N, 60°52′W, 1987.II.18. INPA 4874 (1, 132), Rio Uraricoera, Ilha Maracá, 03°02′N, 60°30′W, 1988.III.11. INPA 6412 (2, 262–361), Rio Mucajai, Cachoeira Paredão, 02°25′N, 60°52′W, 1986.X.03. INPA 6419 (1, 317), Rio Mucajai, Cachoeira Paredão, 02°25′N, 60°52′W, 1987.II.19. INPA 7417 (1, 113), Rio Branco, Igarapé Juruaquim, 03°22′N, 60°19′W, 1992.III.27. Tocantins: INPA 4536 (1, 166), Rio Tocantins, Itupiranga, 05°09′S, 49°20′W, 1980.VII.06. INPA 4825 (1, 460), Rio Tocantins, Lago Grande, 05°09′S, 49°20′W, 1981.XI.21. INPA 6415 (1, 193), Rio Tocantins, Itupiranga, 05°09′S, 49°20′W, 1982.VII.29. Ecuador: Napo: FMNH 103297 (1, 275), Río Payamino, 00°26′S, 77°2′12″W, 1981.IX.20. FMNH 103299 (3, 130–300), Río Sardinas, 00°06′S, 77°12′30″W, 1981.IX.29. FMNH 103300 (2, 210–368), Río Napo, 00°23′24″S, 76°37′06″W, 1981.X.04. Guyana: Essequibo: UMMZ 215834 (2, 138–435), tidal canal at Anna Regina, 07°16′N, 58°30′W, 1971.VIII.27. Paraguay: Canendiyu: UMMZ

206424 (1, 173), Río Paraguay, Canendiyu, 24°02′12″S, 54°19′W, 1979.VII.13. Concepcion: UMMZ 206765 (1, 500), Río Aquidaban, Parque Cerro Cora, 22°38′12″S, 56°03′W, 1979.VII.25. UMMZ 206794 (1, 136), Río Apa, near Bella Vista, 22°06′30″S, 56°30′W, 1979.VII.27. UMMZ 208004 (1, 102), Río Paraguay, Concepcion, 23°15′18″S, 56°30′W, 1979.IX.11. Peru: Cajamarca: ROM 5228 (1, 163), Río Tabaconas, 05°23′S, 78°45′W, 1986.VII.7. Loreto: UF 116550 (1, 481), Río Nanay, Mixana, 03°52′46″S, 73°29′33″W, 2001.III.26. UF 117121 (2, 427–453), Río Nanay, Mixana, 03°52′46″S, 73°29′33″W, 2001.III.26. UF 122829 (1, 174), near Iquitos, 03°46′S, 73°15′W, 2002.V.20–28. UF 122830 (1, 188), near Iquitos, 03°46′S, 73°15′W, 2002.V.20–28. UF 122831 (1, 142), near Iquitos, 03°46′S, 73°15′W, 2002.V.20–28. UF 122832 (1, 101), near Iquitos, 03°46′S, 73°15′W, 2002.V.20–28. UF 122835 (1, 139), near Iquitos, 03°46′S, 73°15′W, 2002.V.20–28. UF 122838 (1, 127), near Iquitos, 03°46′S, 73°15′W, 2002.V.20–28. UMMZ 187220 (1, 185 SL), Río Purus, Río Curanja, 10°08′S, 71°13′W, 1966.VII. Madre de Dios: USNM 263888 (1), Río Madre de Dios, Tambopata, 12°49′S, 69°16′W, 1983.VIII.20. Ucayali: ROM 55540 (1, 167), Río Ucayali, Pucallpa, 08°23′S, 74°32′W, 1988. Suriname: Marowijne: UF 16268 (1, 197), Marowijne River, 05°30′N, 54°03′W, 1967.VII. Venezuela: Apure: UF 80888 (2, 168–198), Río Apure, Munoz, 07°25′20″N, 69°35′40″W, 1979.II.13. Portuguesa: UF 80862 (2, 195–206), Laguna Chiriguare, 1984.IV.03.

Sternopygus xingu.—Brazil: Mato Grosso: UMMZ 228961 (3, 190–223, paratype), Rio Batovi, 13°′S, 53°30′W, 1964.VIII. Pará: INPA 6418 (1, 353), Rio Tocantins, Tucuruí, 03°42′S, 49°42′W, 1980.X.31. INPA 6425 (1, 305), Rio Tocantins, Breu Branco, 04°01′59″S, 49°40′W, 1982.VII.11. INPA 6426 (1, 463), Rio Tocantins, Lago Taua, 03°42′S, 49°42′W, 1980.X.31. INPA 6418 (1, 354), Rio Tocantins, 05°01′S, 50°40′W, Tocantins: INPA 6420 (1, 485), Rio Tocantins, Itupiranga, 05°08′05″S, 49°19′36″W, 1982.VII.29. INPA 6427 (1, 455), Rio Tocantins, Lago Grande, 05°09′S, 49°20′W, 1981.XI.21.

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Literature Cited

Albert, J. S. 2001. Species diversity and phylogenetic systematics of American Knifefishes (Gymnotiformes, Teleostei). Misc. Publ. Mus. Zool., Univ. Mich. 190:1–127.

———, and W. G. R. Crampton. 2001. Five new species of *Gymnotus* (Teleostei: Gymnotiformes) from an Upper Amazonian floodplain, with descriptions of electric organ discharges and ecology. Ichthyol. Explor. Fresh. 12:241–266.

———, and W. L. Fink. 1996. *Sternopygus xingu*, a new species of electric fish from Brazil (Teleostei, Gymnotoidei), with comments on the phylogenetic position of *Sternopygus.* Copeia 1996:85–102.

Alves-Gomes, J. A. 1997. Informações preliminares sobre a bio-ecologia de peixes elétricos (Ordem Gymnotiformes) em Roraima, p. 47–55. *In:* Homen, Ambiente e Ecologia no Estado do Roraima. R. I. Barbosa, E. J. G. Ferreira, and E. G. Castellón (eds.). INPA, Manaus, Brazil.

Bloch, M. E., and J. G. Schneider. 1801. Systema Ichthyologiae iconibus cx illustratum. Post obitum auctoris opus inchoatum absolvit, correxit, interpolavit Jo. Gottlob Schneider, Saxo. Berolini. Sumtibus Austoris Impressum et Bibliopolio Sanderiano Commissum. Systema Ichthyol.:i–lx + 1–584, Pls. 1–110.

Castelnau, F. 1855. Poissons nouveaux ou rares recueillem pendant l'Expedition dans les parties centrales de l'Amerique du Sud, de Rio de Janeiro a Lima, et de Lima au Pará. Chez P. Bertrand, Libraire Editeur, Paris.

Cox Fernandes, C. 1998. Detrended canonical correspondence analysis (DCCA) of electric fish assemblages in the Amazon, p. 21–39. *In:* Biology of tropical fishes. A. L. Val and V. M. F. Almeida-Val (eds.). INPA, Manaus, Brazil.

Crampton, W. G. R. 1996a. Gymnotiform fish: an important component of Amazonian flood plain fish communities. J. Fish Biol. 48:298–301.

———. 1996b. The electric fish of the Upper Amazon: ecology and signal diversity. Unpubl. Ph.D. diss., Univ. of Oxford, Oxford.

———. 1998a. Electric signal design and habitat preferences in a species rich assemblage of gymnotiform fishes from the Upper Amazon basin. Ann. Acad. Bras. Ci. 70:805–847.

———. 1998b. Effects of anoxia on the distribution, respiratory strategies and electric signal diversity of gymnotiform fishes. J. Fish Biol. 53(Supp. A):307–330.

———. 1999. Os peixes da Reserva Mamirauá: diversidade e história natural na planície alagável da Amazônia, p. 10–36. *In:* Estratégias para Manejo de Recursos Pesqueiros em Mamirauá. H. L. Queiroz and W. G. R. Crampton (eds.). Sociedade Civil Mamirauá/CNPq, Brasília, Brazil.

DINGERKUS, G., AND L. D. UHLER. 1977. Enzyme clearing of alcian blue stained whole small vertebrates for demonstration of cartilage. Stain Tech. 52:229–232.

EIGENMANN, C. H., AND W. R. ALLEN. 1942. Fishes of western South America. Univ. of Kentucky, Lexington.

———, AND D. P. WARD. 1905. The Gymnotidae. Proc. Wash. Acad. Sci. 7:158–188.

ELLIS, M. M. 1913. The gymnotid eels of tropical America. Mem. Carnegie Mus. 6:109–195.

EYDOUX, J. F. T., AND F. L. A. SOULEYET. 1841. Poissons, p. 155–216. *In:* Voyage autour du monde executé pendant les années 1836 et 1837 sur le corvette La Bonité. Vol. 1 (2). Paris.

FERNÁNDEZ-YÉPEZ, A. 1968. Contribucion al conocimento de los peces gymnotiformes. Evencias. 20: 5 pp (no pagination).

HEILIGENBERG, W. 1991. The neural basis of behavior: a neuroethological view. Annu. Rev. Neurosci. 14: 247–267.

HOPKINS, C. D. 1972. Sex differences in electric signaling in an electric fish. Science 199:1001–1003.

———. 1974. Electric communication in the reproductive behavior of *Sternopygus macrurus* (Gymnotoidei). Z. Tierpsychol. 35:518–535.

HUMBOLDT, A. VON, AND A. BONPLAND. 1811. Recueil d'observations de zoologie et d'anatomie comparée, faites dans l'ocean Atlantique, dans l'intérieur du nouveau continent et dans la mer du sud pendant les années 1799, 1800, 1801, 1802 et 1803. Chez Levrault, Schoell et comp, Paris.

LEVITON, A. E., R. H. GIBBS JR., E. HEAL, AND C. E. DAWSON. 1985. Standards in herpetology and ichthyology. Part I. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. Copeia 1985:802–832.

LUNDBERG, J., G., AND F. MAGO-LECCIA. 1986. A review of *Rhabdolichops* (Gymnotiformes, Sternopygidae), a genus of South American freshwater fishes, with description of four new species. Proc. Acad. Nat. Sci. Phila. 138:53–85.

MAGO-LECCIA, F. 1978. Los peces de la familia Sternopygidae de Venezuela. Acta Cient. Venez. 29:1–89.

———. 1994. Electric fishes of the continental waters of America. Biblioteca de la Academia de Ciencias Fisicas, Matematicas y Naturales, Caracas 29:1–206.

MCANELLY, L., A. SILVA, AND H. H. ZAKON. 2003. Cyclic AMP modulates electrical signaling in a weakly electric fish. J. Comp. Physiol. A 189:273–282.

MEEK, S. E., AND S. F. HILDEBRAND. 1916. The fishes of the fresh-water of Panama. Field Mus. Nat. Hist. Publ. No. 191, ser. Zool. 10:217–374.

MÜLLER, J., AND F. H. TROSCHEL. 1849. Horae Ichthyologice. beschreibung und Abbildung neuer Fische. Drittes Heft, Berlin, Germany.

REINHARDT, J. 1852. Om svommeblaeron hos familien Gymnotini. Vidensk. Meddel. fra den Naturhistoriske Forening i Kjobenhavn 9:135–149.

SCHULTZ, L. P. 1949. A further contribution to the ichthyology of Venezuela. Proc. U.S. Nat. Mus. 99: 1–211.

STEINDACHNER, F. 1881. Beiträge zur Kenntniss der Flussfische Südamerika's. II. Denkschriften der Akademie der Wissenshaften in Wien 43:103–146, pl 2.

TRIQUES, M. L. 2000. *Sternopygus castroi*, a new species of Neotropical electric fish, with new synapomorphies to the genus (Sternopygidae: Gymnotiformes: Teleostei). Stud. Neotrop. Fauna Environ. 35:19–26.

UNGUEZ, G. A., AND H. H. ZAKON. 1998. Phenotypic conversion of distinct muscle fiber populations to electrocytes in a weakly electric fish. J. Comp. Neurol. 399:20–34.

WEITZMAN, S. H. 1962. The osteology of *Brycon meeki*, a generalized characid fish, with an osteological definition of the family. Stanford Ichth. Bull. 8:1–77.

(WGRC, JSA) FLORIDA MUSEUM OF NATURAL HISTORY, UNIVERSITY OF FLORIDA, GAINESVILLE, FLORIDA 32611; AND (KGH) DEPARTMENT OF ZOOLOGY, UNIVERSITY OF FLORIDA, GAINESVILLE, FLORIDA 32611. E-mail: (WGRC) willc@flmnh.ufl.edu. Send reprint requests to (WGRC). Submitted: 30 April 2003. Accepted: 24 Oct. 2003. Section editor: J. W. Armbruster.