







Gymnotiform electric fishes of the Tres Fronteras region of the western Amazon

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Abstract. Gymnotiform electric knifefishes are an important yet undersampled component of the Neotropical aquatic biota. We report on the gymnotiform fauna of the Tres Fronteras region located at the triple border of Brazil, Colombia, and Peru in the biodiverse western Amazon. The presence of at least 33 species of gymnotiforms in the Tres Fronteras region is validated from recent sampling efforts and the review of previously collected materials. A key is provided for the identification of the species that have been collected from the region. We comment on the diversity of habitat utilization and intraspecific colour variation of some species.

Keywords. Biodiversity, Brazil, Colombia, ichthyology, knifefish, Ostariophysi, Peru

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Introduction

The Tres Fronteras (in Portuguese, Tríplice Fronteira) refers to the area where the borders of Brazil, Colombia, and Peru meet along the upper Amazon river. This region is home to one of the larger human communities in the western Amazon, with Leticia (Colombia) and Tabatinga (Brazil) nearly merging on the north bank, and Santa Rosa de Yavarí (Peru) partway across the river on an island to the south. Due to the existing infrastructure, increasing population, and high migratory mobility between the three cities, this region has become a hub for local trade and tourism (Oliveira 2006; Lapola et al. 2021). Together, these three cities and the surrounding Indigenous communities have a human population of over 115,000 people (IBGE 2023; INEI 2023), which is steadily increasing and obtains a substantial amount of animal protein from local fish products (Murrieta et al. 2008). This puts pressure on local aquatic resources and provides an urgency for a

better understanding of the composition and ecology of the ichthyofauna of this region.

The Tres Fronteras region lies at the heart of the Western Amazonian Endemic Area (Kullander 1986), a biological province with more fish species than any other freshwater region of comparable size on Earth (Tedesco et al. 2017; Cassemiro et al. 2023). There are over 1,000 fish species known from this region with an area of about 1.6 million km² and extending from the Andean piedmont of Colombia, Ecuador, and northern Peru to the mouth of the rio Purús in Brazil (Albert et al. 2011; Cassemiro et al. 2023). Although this region is still predominantly undeveloped, it is experiencing unprecedented economic activities, with rapid degradation of its many terrestrial and aquatic biotic resources (Tagliacollo et al. 2021).

Here we report on the species richness of one ecologically important component of the ichthyofauna in the western Amazon: the weakly electric knifefishes of the order Gymnotiformes. This group is an abundant but

often underestimated component of Neotropical aquatic ecosystems. To date, over 270 valid gymnotiform species have been described from throughout the Neotropics (Fricke et al. 2023), with about 94 species and 24 endemic species in the lowland Amazon basin (van der Sleen and Albert 2017). Despite a largely conserved body plan characterized by an elongate anal fin and the absence of dorsal, pelvic, or adipose fins, gymnotiform fishes exhibit a diversity of head and body shapes, and differ in eco-physiology, diet, habitat, and life history. Their ability to produce and detect weak electric fields allows these fishes to communicate, navigate, and find food and mates in nearly every freshwater habitat across the humid lowlands (i.e. below 250 m elevation) of the Neotropical realm (Albert and Crampton 2005). However, many of these species inhabit remote or largely inaccessible and difficult habitats to reach or sample, and these species' largely cryptic and nocturnal behaviour makes most gymnotiform fishes difficult to collect on a large scale without using specialist equipment and careful planning (Albert and Crampton 2005; Lundberg et al. 2013; Haag et al. 2019). Therefore, gymnotiform fishes have become chronically underreported in most published regional inventories and databases and underrepresented in museum collections (Albert and Reis 2011).

We provide a checklist of the gymnotiforms that inhabit the main channel of the Amazon, associated floodplain lakes, and terra firme (non-floodplain) streams in the Colombian portion of the Tres Fronteras region. This checklist is the result of a multi-year sampling effort conducted by us, using collecting methods that specifically target these fishes and supplemented by specimens from this region deposited by other collectors in natural history museum collections. Such a work conveys the regional diversity of a gymnotiform fauna, provides insights into the ecology, evolution, and sampling of these species, offers resources for freshwater biologists working in the Tres Fronteras region, and advances the complete characterization of the biodiverse western Amazon.

Study Area

The hydrology of the Tres Fronteras region is dominated by the whitewater (i.e. sediment and nutrient rich, pH 6.6–7.48, conductivity 105–149 $\mu\text{S}/\text{cm}$) Amazon river, which provides a major habitat and means of dispersal for most aquatic organisms of this region (Schiesari et al. 2003; Hurd et al. 2016). Seasonal fluctuations of the river's water level vary on average by 8.6 m, although extreme fluctuations can be up to 12.1 m (Goulding et al. 2003). This regular flooding creates seasonally inundated floodplain forest and lake habitats, which constitute approximately 2% of the land surface area in the region (Paiva et al. 2013). Above the level of the seasonal inundation exist low-order terra firme streams and small rivers that together constitute most of the length of the regional river network but only a tiny fraction

(~0.3%) of the total land surface area (Downing et al. 2012).

Outside Leticia, Colombia, the Yaguaraca (also spelled Yahuarkaka) floodplain lake system is a series of 21 interconnected lakes intermittently connected to the Amazon and which seasonally inundate the surrounding forest and communities. Multiple blackwater (i.e. acidic, sediment and nutrient poor, pH 5–6, conductivity 52–61 $\mu\text{S}/\text{cm}$) terra firme streams drain into the lakes with a low-amplitude annual flood cycle (Fig. 1). This study reports species collected from the river channel and tributaries, floodplain lakes, and terra firme streams in Colombia which exist along the approximately 50 km stretch of the Amazon that forms the border with Peru between Tabatinga, Brazil and the indigenous community of Macedonia in Colombia (Fig. 2). Collection sites summarized in Table 1.

Methods

Most of the specimens used in this work were collected by us between November 2021 and August 2022. These materials were supplemented by additional specimens collected from the region and previously deposited in the CIACOL (Sinchi) and MCZ (Harvard) collections. Sampling techniques during the 2021–2022 collections depended on demands of the different habitats (Fig. 3). Various sites along the Amazon and its tributaries between Leticia and the Macedonia community were trawled during the early morning and afternoon using a 12-ft shrimp trawl attached to a small outboard-motor vessel. Approximately 100–300 m stretches along sandy beaches, river margins, and river channels were trawled at a time. Trawl length depended heavily on the extent of unobstructed habitat that was available at each site. The Yaguaraca floodplain lake system outside the city of Leticia was sampled in both the day and night using 6 m beach seine nets with 1/8" stretch mesh and a series of gill nets from 1¼–4" mesh size. Gymnotiforms were located and collected from among the abundant floating vegetation composed mostly of *Pontederia* (*Eichhornia*) *crassipes* (Mart.) Solms using a commercially available handheld electronic amplifier similar to that described by Crampton et al. (2007) and a beach seine or dip nets. An aux cable is inserted into the amplifier and the other end is cut with the internal wires exposed and splayed. The cable is attached to a pole and used to probe for electric fish under the water. The electric signals broadcasted in the water are converted to audio using the amplifier allowing for the quick locating and capture of specimens (Fig. 3A). Terra firme stream sites were sampled in the mornings using electronic amplifiers and both seine and dip nets with 1/8" stretch mesh size. Specimens were euthanized in a solution of diluted clove oil and/or ice, and then fixed in a 10% formalin solution in a flat tray for at least 48 h. Specimens were then washed in water and placed in 70% EtOH for long-term storage. Tissue samples for DNA and stable isotope analyses were extracted from the specimens before

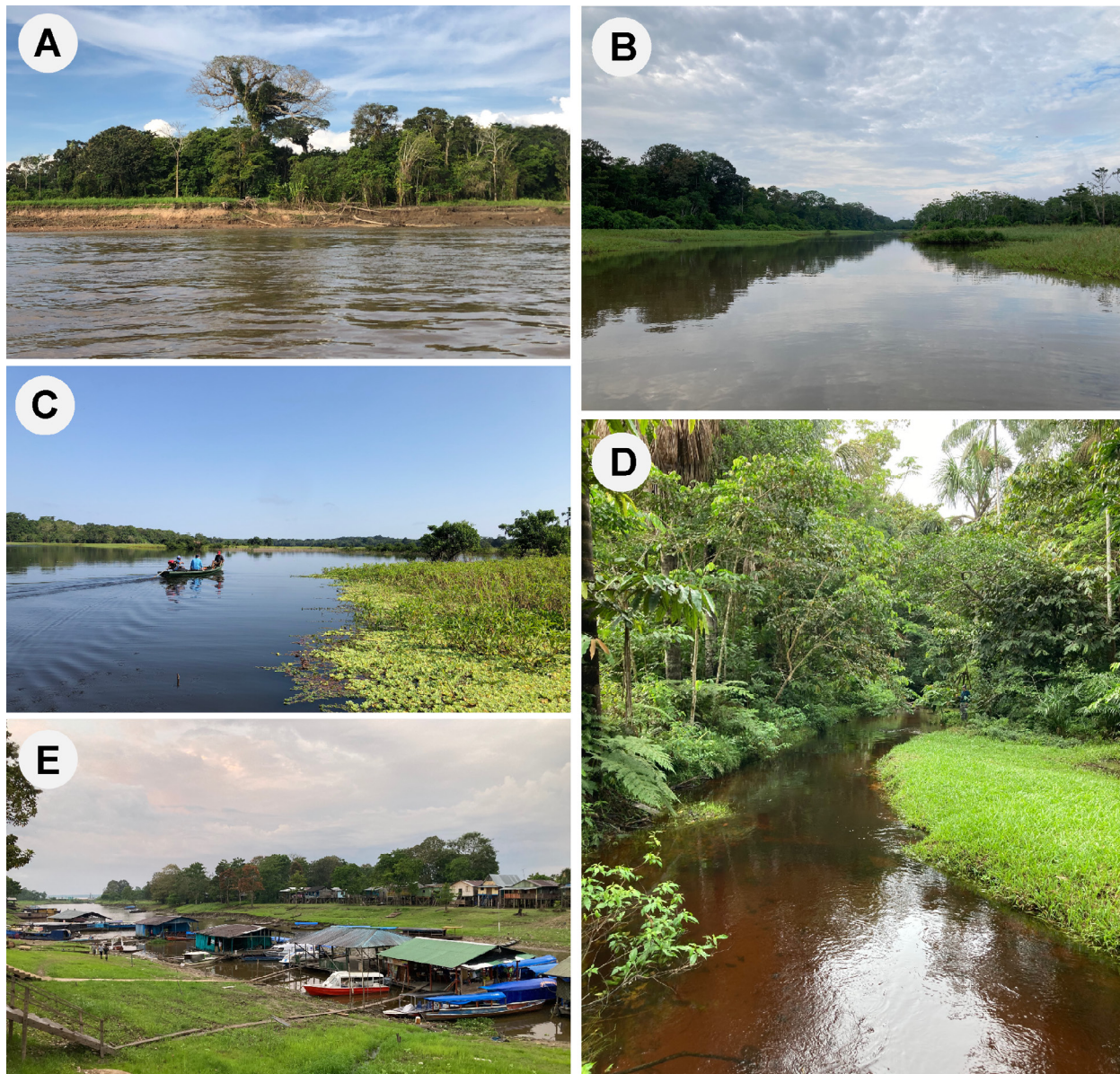


Figure 1. Representative freshwater aquatic habitats in the Tres Fronteras region. **A.** North bank of río Amazonas between Leticia, Colombia, and the community of Macedonia. **B.** Caño Arara near its confluence with the río Amazonas. **C.** Yaguaraca lake system. **D.** Quebrada La Arenosa. **E.** Port of Leticia, Colombia, during season of low water.

formalin fixation and stored in 95% ethanol. All specimens were deposited at the Colección Ictiológica de la Amazonia Colombiana (CIACOL) in Leticia, Colombia. Total length (TL) measured in mm from anterior-most tip of snout to end of tail is reported for all figured specimens.

Results

We validate the presence of at least 33 species of gymnotiform fishes for the region spanning all five gymnotiform families and 20 genera, including 13 new records (Table 2). Most of the species documented from this region occur in the river-channel habitats (64%), followed by non-inundated terra firme (27%), and floodplain lakes and forests (24%; Fig. 4). Endemics to each

habitat: channel only (58%), floodplain only (12%), terra firme only (18%), C+FP (3%), FP+TF (6%), Eurytopic (all three; 3%).

Family Apterontidae

Adontosternarchus balaenops (Cope, 1878)

Figure 5A

New records. COLOMBIA – Amazonas • Grassy bank near Nazaret community; 04°07'07"S, 070°02'46"W; 63 m elev.; 12.IX.2021; K.T. Torgersen, A.H. Fronk, J.D. Bogotá-Gregory, W. Quintero-Silva leg; trawl net; ethanol preservation; 1 specimen, CIACOL 5706; 1 specimen, CIACOL 5712; 1 specimen, CIACOL 5714 • Steep bank at confluence of La Beatriz and río Amazonas; 04°08'02"S, 070°00'05"W; 68 m elev.; 13. IX. 2021;

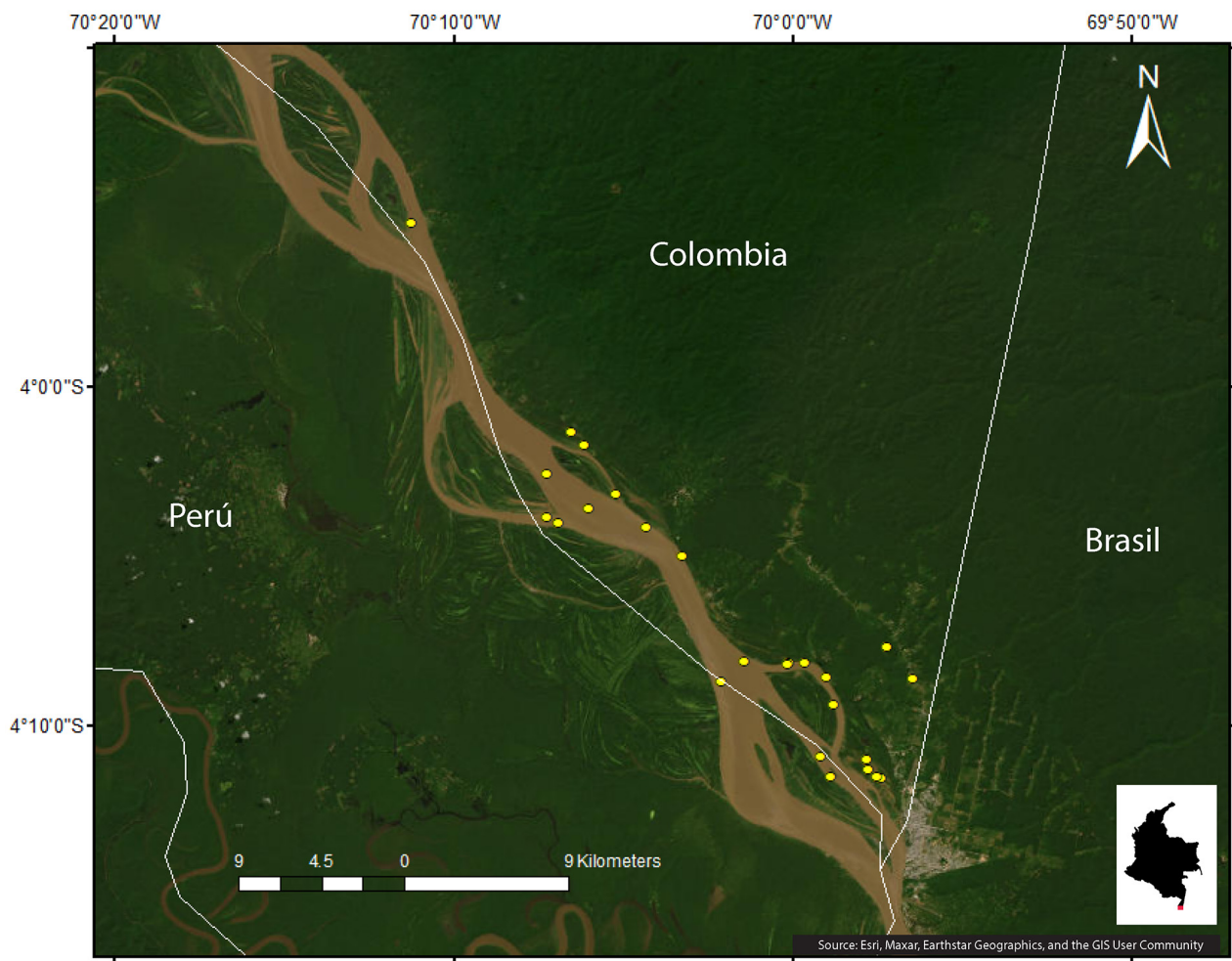


Figure 2. Map of the Tres Fronteras region with major localities sampled during the 2021–2022 field seasons indicated by yellow circles. Circles may indicate more than one collection effort.

Table 1. Summary of major sites sampled during the 2021–2022 field collections.

| Site | Locality description | Latitude | Longitude | Site | Locality description | Latitude | Longitude |
|------|---|----------|-----------|------|---|----------|-----------|
| 1 | Amazon River at west bank of isla Rondina | −04.1817 | −069.9858 | 13 | South bank of isla Corea | −04.0639 | −070.1208 |
| 2 | Amazon River channel south of isla Rondina | −04.1911 | −069.9814 | 14 | Channel of tributary south of isla Corea | −04.0664 | −070.1156 |
| 3 | La Beatriz tributary of Amazon River | −04.1425 | −069.9836 | 15 | Amazon River at Zaragoza community | −03.9189 | −070.1878 |
| 4 | La Pichuna tributary of Amazon River | −04.1350 | −070.0019 | 16 | Amazon River margin 2km north of Nazaret community | −04.0831 | −070.0544 |
| 5 | La Pichuna confluence with Amazon River | −04.1360 | −070.0024 | 17 | Amazon River at Nazaret community | −04.1344 | −070.0240 |
| 6 | Amazon River channel west of isla Ronda | −04.1556 | −069.9797 | 18 | Amazon River 5km south of Nazaret community | −04.1444 | −070.0353 |
| 7 | Mouth of Tucuchira River | −04.0283 | −070.1028 | 19 | Branch of Amazon River 1.5km north of military base | −04.1351 | −069.9943 |
| 8 | Tucuchira River | −04.0217 | −070.1089 | 20 | Yaguaracaca lake system, 3rd lake north end | −04.1922 | −069.9564 |
| 9 | Amazon River channel west of isla de los Micos | −04.0592 | −070.1003 | 21 | Yaguaracaca lake system, 3rd lake east end | −04.1917 | −069.9586 |
| 10 | Amazon River beach at west bank of isla de los Micos | −04.0522 | −070.0867 | 22 | Yaguaracaca lake system, 4th lake | −04.1879 | −069.9631 |
| 11 | Amazon River channel south of isla de los Micos | −04.0686 | −070.0722 | 23 | Yaguaracaca lake system, 5th lake | −04.1831 | −069.9636 |
| 12 | Amazon River channel between isla Corea and isla de los Micos | −04.0422 | −070.1208 | 24 | La Ponderosa stream | −04.1431 | −069.9406 |
| | | | | 25 | La Arenosa stream | −04.1273 | −069.9538 |



Figure 3. Select methods used to collect gymnotiform knifefishes in the field. **A.** J.D. Bogotá-Gregory demonstrates the use of a handheld electric amplifier to locate electrogenic fishes in a mat of aquatic vegetation with the help of J. Montalvo and sons at the Yaguaraca lake system. **B.** R.J. Torgersen removes a doradid catfish from the trawl net after sampling the deep channel of the Amazon river. **C.** K.T. Torgersen uses a dipnet in a small creek near a road crossing outside Leticia. **D.** K.T. Torgersen and J.D. Bogotá-Gregory deploy a trawl net in the main channel of the Amazon.

K.T. Torgersen, A.H. Fronk, J.D. Bogotá-Gregory, W. Quintero-Silva leg.; trawl net, ethanol preservation; 1 specimen; CIACOL 5708 • Steep grassy bank near confluence of La Beatriz with río Amazonas; 04°08'06"S, 069°59'59"W; 65 m elev.; K.T. Torgersen, A.H. Fronk, J.D. Bogotá-Gregory, W. Quintero-Silva leg.; trawl net, ethanol preservation; 1 specimen; CIACOL 5709 • Grassy bank along río Amazonas; 04°03'08"S, 070°07'06"W; 66 m elev.; 13.XI.2021; K.T. Torgersen, A.H. Fronk, I. González-Gómez, W. Quintero-Silva leg.; trawl net, ethanol preservation; 1 specimen, CIACOL 5707; 1 specimen, CIACOL 5710; 1 specimen, CIACOL 5711; 1 specimen, CIACOL 5713 • Submerged sandy beach ~40 m from shore of small island near isla Rondina; 04°11'23"S, 069°58'52"W; 64 m elev.; 1.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1

specimen; CIACOL 6601 • Sandy beach along length of isla de Los Micos; 04°03'08"S, 070°05'12"W; 65 m elev.; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6622 • Sandy beach of arm of río Amazonas that separates isla Corea from Peru; 04°03'59"S, 070°06'56"W; 64 m elev.; 3.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 12 specimens; CIACOL 6631 • Sandy beach and gramalote patches across from Zaragoza community; 03°55'08"S, 070°11'16"W; 64 m elev.; 5.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva, M.P. Valverde leg.; trawl net; ethanol preservation; 1 specimen, CIACOL 6650; 1 specimen, CIACOL 6666.

Identification. Body and head mottled yellow-orange and brown-black; caudal fin present (most individuals

Table 2. List of gymnotiform species collected and/or verified from the Tres Fronteras region. Habitat abbreviations for multiple habitats include river channel (RC), terra firme (TF), and floodplain (FP).

| Family | Species | Habitat | New record | Reference |
|------------------|---------------------------------------|---------------|------------|---|
| Apterotonidae | <i>Adontosternarchus balaenops</i> | River channel | | Lundberg and Cox-Fernandes 2007 |
| Apterotonidae | <i>Apteronotus albifrons</i> | FP + TF | | Albert 2003 |
| Apterotonidae | <i>Apteronotus bonapartii</i> | River channel | | Hilton and Cox-Fernandes 2017 |
| Apterotonidae | <i>Compsaraia samueli</i> | River channel | X | Albert and Crampton 2009; Bernt and Albert 2017 |
| Apterotonidae | <i>Parapteronotus hasemani</i> | RC + FP | | Cox-Fernandes et al. 2002 |
| Apterotonidae | <i>Platyurosternarchus macrostoma</i> | RC + FP + TF | | De Santana and Vari 2009 |
| Apterotonidae | <i>Porotergus duende</i> | River channel | X | De Santana and Crampton 2010 |
| Apterotonidae | <i>Sternarchella calhamazon</i> | River channel | X | Lundberg and Cox-Fernandes 2013 |
| Apterotonidae | <i>Sternarchella orthos</i> | River channel | X | Evans et al. 2017 |
| Apterotonidae | <i>Sternarchogiton nattereri</i> | River channel | X | De Santana and Crampton 2007 |
| Apterotonidae | <i>Sternarchogiton porcinum</i> | River channel | X | De Santana and Crampton 2007 |
| Apterotonidae | <i>Sternarchorhamphus muelleri</i> | River channel | | Campos-da-Paz 1995 |
| Apterotonidae | <i>Sternarchorhynchus cramptoni</i> | River channel | | De Santana and Vari 2010 |
| Apterotonidae | <i>Sternarchorhynchus mormyrus</i> | River channel | | De Santana and Vari 2010 |
| Gymnotidae | <i>Electrophorus multivalvulus</i> | Floodplain | | Craig et al. 2019 |
| Gymnotidae | <i>Gymnotus carapo occidentalis</i> | FP + TF | | Craig et al. 2017 |
| Gymnotidae | <i>Gymnotus coropinae</i> | Terra firme | | Craig et al. 2019 |
| Gymnotidae | <i>Gymnotus javari</i> | Terra firme | X | Albert et al. 2003 |
| Hypopomidae | <i>Brachyhypopomus bennetti</i> | Floodplain | | Sullivan et al. 2013 |
| Hypopomidae | <i>Brachyhypopomus sullivanii</i> | Terra firme | X | Crampton et al. 2017 |
| Rhamphichthyidae | <i>Gymnorhamphichthys rondoni</i> | Terra firme | | Carvalho 2013 |
| Rhamphichthyidae | <i>Hypopygus lepturus</i> | Terra firme | | De Santana and Crampton 2011 |
| Rhamphichthyidae | <i>Rhamphichthys pantherinus</i> | River channel | | Carvalho and Albert 2015 |
| Rhamphichthyidae | <i>Rhamphichthys rostratus</i> | River channel | | Carvalho 2013 |
| Rhamphichthyidae | <i>Steatogenys elegans</i> | River channel | | Crampton et al. 2004 |
| Sternopygidae | <i>Distocyclus conirostris</i> | River channel | | Dutra et al. 2014 |
| Sternopygidae | <i>Eigenmannia limbata</i> | River channel | | Waltz 2019; Maldonado-Ocampo 2011 |
| Sternopygidae | <i>Eigenmannia loreтана</i> | Terra firme | X | Waltz and Albert 2018 |
| Sternopygidae | <i>Eigenmannia nigra</i> | Floodplain | X | Mago-Leccia 1994; Waltz 2019 |
| Sternopygidae | <i>Eigenmannia cf. macrops</i> | River channel | X | Waltz 2019 |
| Sternopygidae | <i>Rhabdolichops eastwardi</i> | River channel | X | Lundberg and Mago-Leccia 1986 |
| Sternopygidae | <i>Rhabdolichops electrogrammus</i> | River channel | X | Lundberg and Mago-Leccia 1986 |
| Sternopygidae | <i>Sternopygus macrurus</i> | FP + TF | | Hulen et al. 2005; Torgersen and Albert 2022 |

with tail damage); oral teeth absent in adults; mouth V-shaped, with upper jaw inserting into a groove formed by the lower; eye covered with layer of skin; anal-fin rays branched; fins with dark margins.

Type locality. Pebas, río Ampiyacu, río Amazonas, Peru.

Distribution and habitat. Upper Amazon river basin.

References. Lundberg and Cox-Fernandes 2007; Mago-Leccia et al. 1985.

Apteronotus albifrons (Linnaeus, 1766)

New record. COLOMBIA – Amazonas • Quebrada de Yahuaraca, estadero la Ponderosa km 8, vía Leticia-Tarapá; 04°08'35"S, 069°56'26"W; 72 m elev.; 22. IX.2017; A. Acosta-Santos, C. Moreira, F.T. de Lima, J. Flausino leg.; ethanol preservation, 1 individual; CIA-COL 3060.

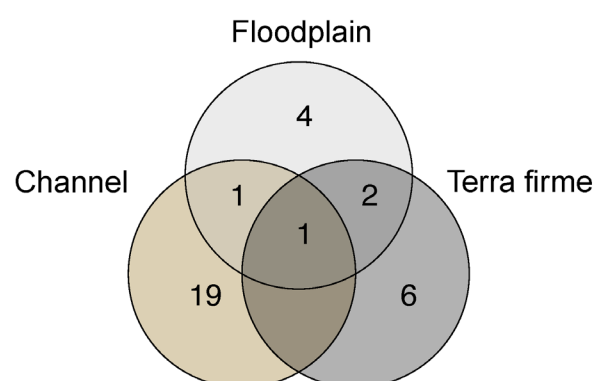


Figure 4. Venn diagrams of habitat type of gymnotiform species in the Tres Fronteras region. Numbers indicate numbers of species known to occur in each distinct habitat type. *Platyurosternarchus macrostoma* is the species known to inhabit all three habitats.

Identification. Body and fins jet black; body with cream band extending from tip of snout to middorsum; end of tail with 1–3 white bands; eye covered with layer of skin; mouth large; rictus extends to vertical with eye, caudal fin present; anal-fin rays mostly branched.

Type locality. Suriname.

Distribution and habitat. Widespread in cis-Andean freshwater habitats.

Remarks. Sexually dimorphic, with mature adult males having noticeably longer snouts and oral jaws, and maximum body sizes. Adult males are aggressive and actively defend territories against conspecific males.

References. Albert 2003; De Santana 2002; Maulana et al. 2021.

Apteronotus bonapartii (Castelnaud, 1855)

Figure 5B

New records. COLOMBIA – Amazonas • Sandy beach along length of isla de Los Micos; 04°03'08"S, 070°05'12"W; 65 m elev., K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6618 • Sandy beach of arm of río Amazonas that separates isla Corea from Peru; 04°03'59"S, 070°06'56"W; 64 m elev.; 3.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 4 specimens; CIACOL 6632 • Shallow area of río Amazonas near isla de Los Micos; 04°03'33"S, 070°06'01"W; 64 m elev.; 3.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6644 • Sandy beach and gramalote patches across from Zaragoza community; 03°55'08"S, 070°11'16"W; 64 m elev.; 5.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva, M.P. Valverde leg.; trawl net; ethanol preservation; 1 specimen, CIACOL 6648; 1 specimen, CIACOL 6654; 1 specimen, CIACOL 6667.

Identification. Body colouration variable, ranging from pale ground colour with countershading and pink undertones to dark, black; anal fin with pale proximal margins and dark distal margins; mouth large; rictus of mouth extends to eye; eye covered with layer of skin; caudal fin present; anal-fin rays mostly branched.

Type locality. Lake emptying into río Ucayali, Peru.

Distribution and habitat. River channels and margins in the Amazon river basin.

Remarks. Sexually dimorphic, with males having noticeably longer snouts and oral jaws.

References. Hilton and Cox-Fernandes 2006, 2017; Albert et al. 2012.

Compsaraia samueli Albert & Crampton, 2009

Figure 5C

New records. COLOMBIA – Amazonas • río Amazonas, frente a la comunidad de Nazaret; 04°07'44"S, 070°03'09"W; 66 m elev.; 12.IX.2021; K.T. Torgersen, A.H.

Fronk, J.D. Bogotá-Gregory, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 5684 • Submerged sandy beach ~40 m from shore of small island near isla Rondina; 04°11'23"S, 069°58'52"W; 64 m elev.; 1.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 2 specimens; CIACOL 6602 • Sandbar east of isla de Los Micos; 04°04'07"S, 070°04'20"W; 64 m elev.; 2.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6626 • Shallow area of río Amazonas near isla de Los Micos; 04°03'33"S, 070°06'01"W; 64 m elev.; 3.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6643 • Sandy beach and gramalote patches across from Zaragoza community; 03°55'08"S, 070°11'16"W; 64 m elev.; 5.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva, M.P. Valverde leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6655.

Identification. Body and head pinkish grey in life, yellow in preserved specimens, inverted L-shaped supratemporal laterosensory canal clearly visible; pale antorbital stripe from eye to tip of upper jaw oral jaws elongate in some mature males; snout acutely angled in non-mature males, females, and juveniles, scales large; body laterally compressed.

Type locality. Río Amazonas near Iquitos, Peru.

Distribution and habitat. Deep river channels and flooded beaches in the western Amazon basin of Brazil, Colombia, and Peru, and the Rio Negro.

Remarks. *Compsaraia samueli* is known for extreme sexual dimorphism of the length of the oral jaw; however, no adult males with sexually dimorphic elongate snouts have yet been collected from the Tres Fronteras region. Adult males are aggressive and engage in agonistic behaviour and appear not to feed much during this terminal phase. Furthermore, not all reproductive males or large males have elongate oral jaws, suggesting this may be a facultative trait.

References. Albert and Crampton 2009; Bernt and Albert 2017.

Parapteronotus hasemani (Ellis, 1913)

Figure 5D

New records. COLOMBIA – Amazonas • Lago 3, Sistema de lagos Yaguaraca; 04°11'32"S, 069°57'23"W; 63 m elev.; 28.VII.2022; K.T. Torgersen, R.J. Torgersen, M.P. Valverde, J. Montalvo leg.; seine net; ethanol preservation, 1 specimen; CIACOL 6684 • Lago 5, Sistema de lagos Yaguaraca; 04°10'59"S, 069°57'49"W; 63 m elev.; 28.VII.2022; K.T. Torgersen, R.J. Torgersen, M.P. Valverde, J. Montalvo leg.; seine net; ethanol preservation, 1 specimen; CIACOL 6690 • Sandy beach along length of isla de Los Micos; 04°03'08"S, 070°05'12"W; 65 m elev., K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W.

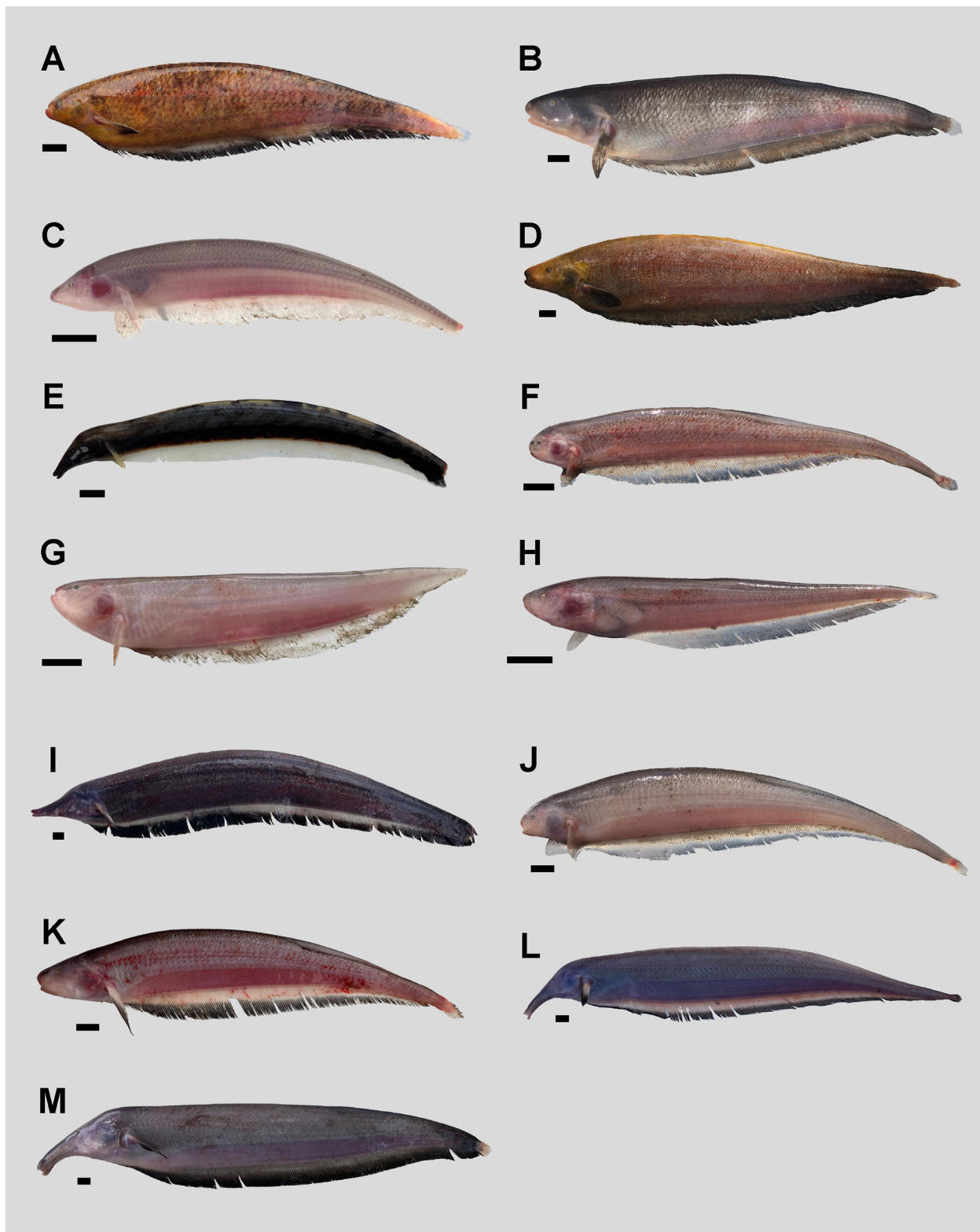


Figure 5. Family Aptereronotidae. All specimens with live colouration. Scale bars = 1 cm. **A.** *Adontosternarchus balaenops* CIACOL 6622, 177 mm TL. **B.** *Aptereronotus bonapartii* CIACOL 6618, 193 mm TL. **C.** *Compsaraia samueli* CIACOL 6626, 98 mm TL. **D.** *Parapteronotus hasemani* CIACOL 6620, 245 mm TL. **E.** *Platyurosternarchus macrostoma* CIACOL 6657, 162 mm TL. **F.** *Porotergus duende* CIACOL 6624, 147 mm TL. **G.** *Sternarchella calhamazon* CIACOL 6600, 100 mm TL. **H.** *Sternarchella orthos* CIACOL 6623, 90 mm TL. **I.** *Sternarchorhamphus muelleri* CIACOL 6658, 362 mm TL. **J.** *Sternarchogiton nattereri* CIACOL 6615, 170 mm TL. **K.** *Sternarchogiton porcinum* CIACOL 6646, 204 mm TL. **L.** *Sternarchorhynchus cramptoni* CIACOL 6627, 310 mm TL. **M.** *Sternarchorhynchus mormyrus* CIACOL 6619, 310 mm TL.

Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6620 • Sandy beach and gramalote patches across from Zaragoza community; 03°55'08"S, 070°11'16"W; 64 m elev.; 5.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva, M.P. Valverde leg.; trawl net; ethanol preservation; 2 specimens, CIACOL 6660; 1 specimen, CIACOL 6674.

Identification. oral jaws elongate in mature males at ~300–320 mm TL; snout square in non-mature males, females, and juveniles; scales small, darkly pigmented; body less laterally compressed than most other deep-channel apteronotids. Ground colour usually dark brown to black, or occasionally orange.

Type locality. Santarem, Pará, Brazil.

Distribution and habitat. Main channels and floodplain lakes in the Amazon river basin in Brazil, Colombia, and Peru.

Remarks. Individuals of both solid orange and solid black pigmentation have been collected together in the Tres Fronteras region. Males are sexually dimorphic, with noticeably longer snouts, oral jaws, and maximum body sizes. Adult males are aggressive towards conspecific males and engage in agonistic behaviour.

References. Cox-Fernandes et al. 2002.

Platyrosteronchus macrostoma (Günther, 1870)

Figure 5E

New record. COLOMBIA – Amazonas • Sandy beach and gramalote patches across from Zaragoza community; 03°55'08"S, 070°11'16"W; 64 m elev.; 5.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva, M.P. Valverde leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6657.

Identification. Snout and jaws elongate and more than ½ head length; mouth large; rictus extending to posterior nares; head decurved, with dorsal margin straight; dorsal body margin sharply angled at nape; head relatively small compared to body length; anal fin hyalin; caudal fin broad, flat; body usually darkly pigmented, with cryptic, mottled pattern.

Type locality. Xeberos (= Jeberos), río Marañon drainage, Amazon river basin, Peru.

Distribution and habitat. Streams and rivers margins with complex cover and sand or clay substrates in the Amazon, Orinoco, and Essequibo river basins.

References. De Santana and Vari 2009.

Porotergus duende De Santana & Crampton, 2010

Figure 5F

New records. COLOMBIA – Amazonas • Shore along eastern corner of isla de Los Micos; 04°03'31"S, 070°05'13"W; 64 m elev.; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6624 • Submerged sandy beach ~40 m from shore of small island near isla Rondina; 04°11'23"S, 069°58'52"W; 64 m elev.;

1.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 2 specimens; CIACOL 6599.

Identification. Body and head light brown. Adult body size small, <140 mm TL; face very short, rounded, with dark freckled pattern; mouth slightly subterminal; caudal fin present.

Type locality. Beach on north bank of Ilha Cuera, near Tefé, Alvarães, Brazil.

Distribution and habitat. Main channels of large whitewater rivers in the central and western Amazon.

Remarks. *Porotergus duende* is similar to and often confused with other *Porotergus* and *Sternarchogiton* species. *Porotergus duende* is most similar to sympatric *P. gimbeli* and *S. nattereri*, from which it can be distinguished by fewer anal fin rays (124–145 vs. 171–198 in *P. gimbeli* and 180–198 in *S. nattereri*) and a proportionally longer pectoral fin (72.7–89.0% of head length vs. 60.4–70.7% in *P. gimbeli* and 8.0–11.3% in *S. nattereri*). *Porotergus duende* is rare in collections available for this study, but two of the three specimens collected have a swollen, red mental chin pad previously thought to be diagnostic of *P. gimbeli*.

References. De Santana and Crampton 2007, 2010.

Sternarchella calhamazon Lundberg & Cox-Fernandes, 2013

Figure 5G

New record. COLOMBIA – Amazonas • Submerged sandy beach ~40 m from shore of small island near isla Rondina; 04°11'23"S, 069°58'52"W; 64 m elev.; 1.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6600.

Identification. Body with few or no surface chromatophores, pinkish in life, pale yellow in preserved specimens; adult body size small, rarely more than 160 mm TL; face short, with slightly superior mouth and robust oral jaws; eyes minute, covered with layer of skin; electric organ truncated posterior to anal fin allowing hemal spines to be visible; precaudal vertebrae 13 or 14.

Type locality. Rio Madeira, 35 km above confluence with río Amazonas, Brazil.

Distribution and habitat. Common in large river channels of the Amazon river and its major tributaries.

Remarks. Believed to be the most abundant species of gymnotiform in the main channels of the Amazon river basin.

References. Lundberg and Cox-Fernandes 2013.

Sternarchella orthos Mago-Leccia, 1994

Figure 5H

New record. COLOMBIA – Amazonas • Sandy beach along length of isla de Los Micos; 04°03'08"S, 070°05'12"W; 65 m elev., K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net;

ethanol preservation; 1 specimen; CIACOL 6623.

Identification. Body with few or no surface chromatophores, pinkish in life, pale yellow in preserved specimens; face short, with terminal mouth and robust oral jaws; electric organ and caudal peduncle elongate posterior to anal fin; precaudal vertebrae 14–16.

Type locality. Río Apure near mouth of the río Boquerones, east of San Fernando de Apure, Apure, Venezuela.

Distribution and habitat. River channels in the Amazon and Orinoco river basins.

Remarks. The type locality of *S. orthos* is in the Orinoco river basin, and although populations are known from both the Orinoco and Amazon river basins, a review of the genus was unable to find consistent morphometric differences to distinguish the two populations, which are currently treated as a single species.

References. Evans et al. 2017.

***Sternarchogiton nattereri* (Steindachner, 1868)**

Figure 5I

New records. COLOMBIA – Amazonas • Grassy bank along río Amazonas; 04°03'08.1"S, 070°07'06"W; 66 m elev.; 13.XI.2021; K.T. Torgersen, A.H. Fronk, I. González-Gómez, W. Quintero-Silva leg.; trawl net, ethanol preservation; 1 specimen, CIACOL 5685; 1 specimen, CIACOL 5686; 1 specimen, CIACOL 5687; 1 specimen, CIACOL 5688; 1 specimen, CIACOL 5689; 1 specimen, CIACOL 5690; 1 specimen, CIACOL 5692; 1 specimen, CIACOL 5693; 1 specimen, CIACOL 5694; 1 specimen, CIACOL 5695; 1 specimen, CIACOL 5696; 1 specimen, CIACOL 5698; 1 specimen, CIACOL 5699; 1 specimen, CIACOL 5700; 1 specimen, CIACOL 5701; 1 specimen, CIACOL 5703; 1 specimen, CIACOL 5704 • río Amazonas, ca. 2 km upstream from Nazaret; 04°04'59"S, 070°03'16"W; 70 m elev.; 2.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6613 • Sandy beach along length of isla de Los Micos; 04°03'08"S, 070°05'12"W; 65 m elev., K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 2 specimens; CIACOL 6615 • Sandy beach of arm of río Amazonas that separates isla Corea from Peru; 04°03'59"S, 070°06'56"W; 64 m elev.; 3.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 4 specimens; CIACOL 6633 • Sandy beach and gramalote patches across from Zaragoza community; 03°55'08"S, 070°11'16"W; 64 m elev.; 5.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva, M.P. Valverde leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6647.

Identification. Body with slight countershading, pinkish over pterygiophores in life, pale yellow in preserved specimens; snout short, with forehead sharply angled above eye in lateral view; oral jaws gracile, with few or

no teeth; terminal males with large external teeth on tip of snout.

Type locality. Barra do Rio Negro, Manaus, Brazil.

Distribution and habitat. River channels and margins of large rivers in the lowlands of the Amazon basin.

Remarks. This species was found very commonly in trawls along the margins of the Amazon. Adult males are aggressive and engage in agonistic towards conspecific males. Not all reproductive males or the largest males have sexually dimorphic external teeth, which suggests this is a facultative trait. Females are not known to develop the external teeth seen in some males. Many adult males with and without external teeth exhibit scratch marks on the head and anterior body region, presumably resulting from agonistic contests. Only one male displaying sexual dimorphism was collected during our sampling, and no others are known from collections in this region (Fig. 6).

References. De Santana and Crampton 2007.

***Sternarchogiton porcinum* Eigenmann & Allen, 1942**

Figure 5J

New records. COLOMBIA – Amazonas • Grassy beach near the Nazaret community; 04°07'07"S 70°02'46"W; 63 m elev.; 12.IX.2021; K.T. Torgersen, A.H. Fronk, J.D. Bogotá-Gregory, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 5705 • Sandy beach and gramalote patches across from Zaragoza community; 03°55'08"S, 070°11'16"W; 64 m elev.; 5.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva, M.P. Valverde leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6646.

Identification. Body with slight countershading, pinkish colour over pterygiophores in life, pale yellow in preserved specimens. Head of medium length, jaw of moderate size, rictus extending to posterior nares. Black margins of pectoral and anal fins.



Figure 6. *Sternarchogiton nattereri* CIACOL 5704, 222 mm TL, male with sexually dimorphic external tooth patches. Photo by Aaron Fronk.

Type locality. Río Huallaga at Yurimaguas, Peru

Distribution and habitat. River channels and margins of large rivers in the lowland Amazon. and Orinoco river basins.

References. De Santana and Crampton 2007.

***Sternarchorhamphus muelleri* (Steindachner, 1881)**

Figure 5K

New records. COLOMBIA – Amazonas • Sandy beach along length of isla de Los Micos; 04°03'08"S, 070°05'12"W; 65 m elev., K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6621 • Sandy beach and gramalote patches across from Zaragoza community; 03°55'08"S, 070°11'16"W; 64 m elev.; 5.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva, M.P. Valverde leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6658 • Sandy beach across from Macedonia community; 03°52'21"S, 070°12'35"W; 68 m elev.; 5.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva, M.P. Valverde leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6680.

Identification. Snout elongate, with small terminal mouth and deeply concave forehead; body colour variable: ground colour often pink or pale in life, with margins of pectoral and anal fins darkly pigmented; ground colour of preserved specimens brown; all anal-fin rays unbranched; body size relatively large, up to 450 mm TL.

Type locality. Amazon river near Pará, Brazil

Distribution and habitat. River channels and margins of large rivers of the Amazon and Orinoco river basins.

Remarks. Pink to dark purple specimens (in life) have been collected from the Tres Fronteras region.

References. Campos-da-Paz 1995.

***Sternarchorhynchus cramptoni* De Santana & Vari, 2010**

Figure 5L

New record. COLOMBIA – Amazonas • Branch of río Amazonas, deep water with high flow ca. 25 m from shore; 04°09'20"S, 069°58'47"W; 63 m elev.; 1.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6627.

Identification. Body grey in life, with purple along pterygiophores; preserved specimens brown. Scales absent along mid-dorsum as far as origin of electroreceptive dorsal organ; snout long, downturned, tubular, gracile, with mouth small; fins pale, with dark margins; eye covered with layer of skin; caudal fin present.

Type locality. Rio Solimões, downstream from the mouth of the río Purus, Amazonas, Brazil.

Distribution and habitat. Widespread along the main stem of the Amazon river from Iquitos, Peru to Pará, Brazil.

References. De Santana and Vari 2010.

***Sternarchorhynchus mormyrus* (Steindachner, 1868)**

Figure 5M

New records. COLOMBIA – Amazonas • Sandy beach along length of isla de Los Micos; 04°03'08"S, 070°05'12"W; 65 m elev., 2.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6619 • Sandy beach and gramalote patches across from Zaragoza community; 03°55'08"S, 070°11'16"W; 64 m elev.; 5.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva, M.P. Valverde leg.; trawl net; ethanol preservation; 1 specimen, CIACOL 6659; 1 specimen, CIACOL 6676 • Sandy beach across from Macedonia community; 03°52'21"S, 070°12'35"W; 68 m elev.; 5.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva, M.P. Valverde leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6678.

Identification. Body grey in life, with purple along length of pterygiophores; preserved specimens largely brown; scales absent along mid-dorsum as far as origin of electroreceptive dorsal organ. Body deep in lateral profile, 1/3 TL (vs. 1/8 in sympatric congeners). Downturned tubular snout terminating with small mouth; snout depth more than twice that of sympatric congeners; fins black or with dark margins; eye covered with layer of skin; anterior anal-fin rays unbranched but otherwise most branched; caudal fin present.

Type locality. Maribitanos, Rio Negro, Brazil.

Distribution and habitat. Margins and channels of large rivers in the upper and central Amazon, río Negro, and río Orinoco. Juveniles are known to occur in várzea habitats.

Remarks. *Sternarchorhynchus mormyrus* has the greatest known geographic range of all members of the genus.

References. De Santana and Vari 2010.

Family Gymnotidae

***Electrophorus multivalvulus* Nakashima, 1941**

Figure 7A

New record. COLOMBIA – Amazonas • Lago Zapatero, Sistema de lagos Yaguaraca; 30.VII.2022; J. Montalvo leg.; ethanol preservation; 2 specimens; CIACOL uncatalogued.

Identification. Body cylindrical; juveniles strongly dorsally countershaded with slate-blue to dark brown in life; adults fading to a lighter dark brown; preserved specimens grey or brown, darker dorsally; mouth terminal; inner oral cavity highly rugose and vascularized as an air-breathing organ; head covered with thick epidermis, with pronounced laterosensory canal pores; ventral margin of head and abdomen pale yellow to light brown or orange in mature males; anal fin extends to posterior margin of tail and confluent with caudal fin; TL up to 2 m or larger. Live specimens must be handled with care as they produce strong electric discharges up to 650 V.



Figure 7. Families Gymnotidae, Hypopomidae, and Rhamphichthyidae. Scale bars = 1 cm. **A.** *Electrophorus multivalvulus* CIACOL uncat., 540 mm TL. **B.** *Gymnotus coropinae* CIACOL 6752, 97 mm TL. **C.** *Brachyhypopomus sullivanii* CIACOL 6753, 94 mm TL. **D.** *Brachyhypopomus bennetti* CIACOL 5728, XX mm TL. **E.** *Gymnorhamphichthys rondoni* CIACOL 6751, 184 mm TL. **F.** *Hypopygus lepturus* CIACOL 6749, 73 mm TL. **G.** *Rhamphichthys pantherinus* CIACOL 6609, 302 mm TL. **H.** *Rhamphichthys rostratus* CIACOL 6675, 381 mm TL. **I.** *Steatogenys elegans* CIACOL 6606, 146 mm TL.

Type locality. Cocha Zapote, Rio Pacaya, Loreto, Peru.

Distribution and habitat. Lowlands of the Amazon river basin.

Remarks. We regard *Electrophorus multivalvulus* Nakashima, 1941 as a senior synonym of *E. varii* De Santana et al., 2019 because only one species of this genus is known from the western Amazon. This issue is not addressed in the original description of *E. varii* (De Santana et al. 2019). *Electrophorus multivalvulus* is sexually dimorphic, with males attaining a longer TL and exhibiting darker orange or red on their throat and abdomen than females (JSA pers. obs.).

References. Campos-da-Paz 2003; Castro 2010; Craig et al. 2019.

***Gymnotus carapo occidentalis* Craig, Crampton, & Albert, 2017**

New record. COLOMBIA – Amazonas • Caño de Yaguarcaca, Leticia; 04°11'40"S, 069°56'59"W; 70 m elev.; 12.IX.2014; G. Aricari leg.; ethanol preservation; 1

specimen; CIACOL 1382

Identification. Like other *Gymnotus*, mouth superior and chromatophore bands alternating dark and light. Distinguished from congeners by the following: chromatophore bands with irregular margins; body deep, more than twice as deep as wide; anal fin with a black margin; posterodorsal margin of the opercle with two pores confluence of suborbital and supraorbital laterosensory canals forming an acute angle.

Type locality. Cocha Zapote, río Pacaya, Loreto, Peru.

Distribution and habitat. western Amazon and Essequibo basins.

References. Craig et al. 2017.

***Gymnotus coropinae* Hoedeman, 1962**

Figure 7B

New records. COLOMBIA – Amazonas • Finca Agape, km 10.5 vía Leticia-Tarapacá, Quebrada la Arenosa; 04°09'00"S 69°56'12"W; 77 m elev.; 23.VII.2022; J.C. Cárdenas-Campo leg.; ethanol preservation; 1

specimen; CIACOL 6748 • Quebrada la Ponderosa, sector alto; 04°08'21"S 69°56'58"W; 81 m elev.; 23.VII.2022; J.C. Cárdenas-Campo leg.; ethanol preservation; 1 specimen; CIACOL 6752.

Identification. Distinguished from congeners by the following: chromatophore bands narrow, pale, with regular margins (absent from anterior body above lateral line); body slender, cylindrical, about as deep as wide; anal fin hyalin; posterodorsal margin of opercle with one pore, confluence of suborbital and supraorbital laterosensory canals forming a right angle.

Type locality. Coropina Creek, Commewijne, Suriname.

Distribution and habitat. Small terra firm rainforest streams. Males are territorial and guard their nesting sites under tree roots, woody debris, and undercut banks every few metres along the stream bed.

References. Craig et al. 2019.

***Gymnotus javari* Albert, Crampton, & Hagedorn, 2003**

New record. BRAZIL – Amazonas • Tabatinga, Rio Solimões; 04°16'S, 069°56'W; 74 m elev.; 19.IX.1865; Thayer Expedition; 8 specimens, MCZ 60005.

Identification. Distinguished from congeners by the following: pigment bands H-shaped, with regular margins on posterior body; body slender, cylindrical, about as deep as wide; anal fin hyalin; posterodorsal margin of opercle with one pore; confluence of the suborbital and supraorbital laterosensory canals forming a right angle.

Type locality. Quebrada Caraná, río Yavari, Loreto, Peru.

Distribution and habitat. Undercut banks and submerged vegetation at the confluence of terra firme streams and in floodplains in the Amazon, lower Napo, Yavari, and Ucayali basins.

References. Albert and Crampton 2003.

Family Hypopomidae

***Brachyhypopomus bennetti* Sullivan, Zuanon, & Cox-Fernandes, 2013**

Figure 7C

New records. COLOMBIA – Amazonas • Floating vegetation near margin of 4th lake in Yaguarcaca lake system; 04°11'16"S, 069°57'47"W; 57 m elev.; 15.XI.2021; K.T. Torgersen, A.H. Fronk, J.D. Bogotá-Gregory, J. Montalvo leg.; seine net; ethanol preservation; 1 specimen, CIACOL 5725; 1 specimen, CIACOL 5726; 1 specimen, CIACOL 5727; 1 specimen, CIACOL 5728; 1 specimen, CIACOL 5729; 1 specimen, CIACOL 5730; 1 specimen, CIACOL 5731; 1 specimen, CIACOL 5732; 1 specimen, CIACOL 5733; 1 specimen, CIACOL 5734; 1 specimen, CIACOL 5735; 1 specimen, CIACOL 5736; 1 specimen, CIACOL 5737; 1 specimen, CIACOL 5738; 1 specimen, CIACOL 5739; 1 specimen, CIACOL 5740; 1 specimen, CIACOL 5741; 1 specimen, CIACOL

5745 • Lado noroeste de sistema de lagos Yaguarcaca; 04°11'30"S, 069°57'31"W; 63 m elev.; 28.VII.2022; K.T. Torgersen, R.J. Torgersen, M.P. Valverde, J. Montalvo leg.; seine net; ethanol preservation; 2 specimens; CIACOL 6689 • Lago 3, sistema de lagos Yaguarcaca; 04°11'32"S, 069°57'23"W; 63 m elev.; 28.VII.2022; K.T. Torgersen, R.J. Torgersen, M.P. Valverde, J. Montalvo leg.; seine net; ethanol preservation; 3 specimens; CIACOL 6683 • Lago 5, Sistema de lagos Yaguarcaca; 04°10'59"S, 069°57'49"W; 63 m elev.; 28.VII.2022; K.T. Torgersen, R.J. Torgersen, M.P. Valverde, J. Montalvo leg.; seine net; ethanol preservation, 1 specimen; CIACOL 6690.

Identification. Distinguished from other toothless knifefishes (Hypopomidae + Rhamphichthyidae) by the following: adult body size intermediate, up to 232 mm TL; body pale brown, with pattern of light brown and gold ground colour and 30–35 dark-brown saddles over dorsum midline to end of anal fin; snout short, about one-third of head length; anal-fin origin posterior to pectoral-fin base; accessory electric organs lacking. Distinguished from sympatric congeners by the following: electric organ large, readily visible in lateral profile on posterior third of body, with six columns of electrocytes above posterior end of anal fin.

Type locality. Paraná do Paracuúba, near mouth of the rio Negro and entrance to Lago Janauari, Amazonas, Brazil.

Distribution and habitat. Floating meadows and river margins of Amazon and its tributaries.

Remarks. This species was found to be highly abundant in the floating meadows of the Yaguarcaca lake system during seasons of both high and low water. No secondary sexual dimorphism known.

References. Sullivan et al. 2013; Crampton et al. 2016.

***Brachyhypopomus sullivanii* Crampton, De Santana, Waddell & Lovejoy, 2016**

Figure 7D

New record. COLOMBIA – Amazonas • Quebrada la Ponderosa, sector alto; 04°08'21"S 69°56'58"W; 81 m elev.; 23.VII.2022; J.C. Cárdenas-Campo leg.; ethanol preservation; 1 specimen; CIACOL 6753.

Identification. Distinguished from other toothless knifefishes (Hypopomidae + Rhamphichthyidae) by the following: adult body size smaller, up to 123 mm TL; body pale brown, with countershading and 10–12 faint pigment saddles restricted to middorsum and irregular, scattered, dark blotches on lateral body surface; snout short, about one-third of head length; anal-fin origin posterior to pectoral-fin base, and accessory electric organs lacking.

Type locality. Stream near Jenaro Herrera, río Ucayali, municipality Requena, Loreto, Peru.

Distribution and habitat. Gently flowing, low-conductivity streams and small rivers in the Amazon, Negro, upper Madeira, Tapajós, Tocantins, Orinoco, and Essequibo basins.

Remarks. No known secondary sexual dimorphism.

References. Crampton et al. 2016.

Family Rhamphichthyidae

***Gymnorhamphichthys rondoni* (Miranda Ribeiro, 1920)**

Figure 7E

New records. COLOMBIA – Amazonas • Quebrada de Yaguaraca, estadero la Ponderosa km 8, vía Leticia–Tarapá; 04°08'35"S, 069°56'26"W; 72 m elev.; 22.IX.2017; A. Acosta-Santos, C. Moreira, F.T. de Lima, J. Flausino leg.; ethanol preservation; 2 specimens; CIA-COL 3069 • Quebrada la Arenosa, sector alto; 04°07'38"S, 069°57'14"W; 87 m elev.; 3.XI.2020; J.D. Bogotá-Gregory leg.; ethanol preservation; 1 specimen; CIA-COL 4698 • Finca Agape, km 10.5 vía Leticia-Tarapacá, Quebrada la Arenosa; 04°09'00"S, 069°56'13"W; 77 m elev.; 23.VII.2022; J.C. Cárdenas-Campo leg.; ethanol preservation; 1 specimen; CIACOL 6751.

Identification. Distinguished from other toothless knifefishes (Hypopomidae + Rhamphichthyidae) by the following: adult body size intermediate, up to 140 mm LEA; body translucent in life, pale yellow to pale brown when preserved; pigment blotches small, dark, restricted to dorsal midline or sometimes coalesced into a dark longitudinal stripe; lateral body surface without pigment; tip of snout and tip of tail often pigmented; snout long, more than one-third head length; anal-fin origin at branchial isthmus, and electric organ extending onto bottom of head.

Type locality. Rio 17 de Fevereiro, tributary of Alto Cautário, Amazonas, Brazil.

Distribution and habitat. Widespread throughout the Amazon, Orinoco, and Guiana basins.

References. Carvalho 2013.

***Hypopygus lepturus* Hoedeman, 1962**

Figure 7F

New records. COLOMBIA – Amazonas • Finca Agape, km 10.5 vía Leticia-Tarapacá, Quebrada la Arenosa; 04°09'00"S, 069°56'13"W; 77 m. elev.; 23.VII.2022; J.C. Cárdenas-Campo leg.; ethanol preservation; 11 specimens; CIACOL 6749.

Identification. Distinguished from other toothless knifefishes (Hypopomidae + Rhamphichthyidae) by the following: adult body size small, up to 116 mm TL, oblique pigment bands 13–15, dark, with irregular margins present along body surface to end of anal fin; dark oblique band over middle of head through eye; anal-fin membrane hyaline; mouth small, terminal; snout short, less than one-third head length, anal-fin origin posterior to pectoral-fin base, supra-pectoral electric organs paired, extending onto back of head behind eyes.

Type locality. Maroni basin (no exact locality), Suriname.

Distribution and habitat. Low-conductivity creeks

and streams in nearly all major drainages of the Amazon, Orinoco, and Guiana basins.

Remarks. No known sexual dimorphism. It is said that this species is a leaf mimic, often lying on one side on stream floors amongst leaf litter.

References. De Santana and Crampton 2011; Sazima et al. 2006.

***Rhamphichthys pantherinus* Castelnau, 1855**

Figure 7G

New records. COLOMBIA – Amazonas • Quebrada La Pichuna at confluence with río Amazonas; 04°08'06"S, 070°00'07"W; 68 m elev.; 1.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 2 specimens; CIA-COL 6609.

Identification. Distinguished from other toothless knifefishes (Hypopomidae + Rhamphichthyidae) by the following: adult body size large, up to 1 m TL; body with irregular, dark pigment saddles, bands, and blotches; snout somewhat elongate, more than one-third head length; anal-fin origin at branchial isthmus; main electric organ extending onto bottom of head. Distinguished from congeners by its shorter snout and a deeper body.

Type locality. Lake near río Ucayali, Peru.

Distribution and habitat. Broadly distributed in large, deep river channels and floodplains across Pan-Amazonia (Amazon, Orinoco, Essequibo and Upper Madeira basins) in whitewater, blackwater, and clearwater rivers and on floodplains.

Remarks: *Rhamphichthys marmoratus* Castelnau, 1855 is a junior synonym of *R. pantherinus* (Ferraris et al. 2017).

References. Carvalho and Albert 2015.

***Rhamphichthys rostratus* (Linnaeus, 1766)**

Figure 7H

New records. COLOMBIA – Amazonas • Quebrada Arara 500 m to confluence with río Amazonas; 04°04'31"S, 070°03'37"W; 65 m elev.; 2.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 2 specimens; CIACOL 6612 • Sandy beach across from isla de Los Micos; 04°02'32"S, 070°07'15"W; 63 m elev.; 3.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 2 specimens; CIACOL 6630 • Sandy beach and heavily vegetated bank of arm of río Amazonas separating isla Corea from Peru; 04°03'50"S, 070°06'59"W; 64 m elev.; 3.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 2 specimens; CIACOL 6637 • Sandy beach and gramalote patches across from Zaragoza community; 03°55'08"S, 070°11'16"W; 64 m elev.; 5.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva, M.P. Valverde leg.; trawl net; ethanol

preservation; 1 specimen, CIACOL 6661; 1 specimen, CIACOL6675.

Identification. Distinguished from other toothless knifefishes (Hypopomidae + Rhamphichthyidae) by the following: adult body size large, up to 1 m TL; body with irregular chromatophore blotches and broken bands; snout long, much more than one-third head length; anal-fin origin at branchial isthmus, electric organ extending onto bottom of head. Distinguished from sympatric congeners by its long, slender snout and a more slender body.

Type locality. South America.

Distribution and habitat. Broadly distributed in large, deep river channels and on floodplains across Pan-Amazonia (Amazon, Tocantins, and Atlantic basins of the Guianas) in whitewater, blackwater, and clearwater rivers.

Remarks. The type specimen for this species cannot be found and is considered lost.

References. Carvalho 2013.

Steatogenys elegans (Steindachner, 1880)

Figure 7I

New records. COLOMBIA – Amazonas • Submerged sandy beach ~40 m from shore of small island near isla Rondina; 04°11'23"S, 069°58'52"W; 64 m elev.; 1.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6603 • río Amazonas channel near isla Rondina; 04°11'28"S, 069°58'53"W; 64 m elev.; 1.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6606 • Shallow area of río Amazonas near isla de Los Micos; 04°03'33"S, 070°06'01"W; 64 m elev.; 3.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6645 • Sandy beach and gramalote patches across from Zaragoza community; 03°55'08"S, 070°11'16"W; 64 m elev.; 5.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva, M.P. Valverde leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6671 • Sandy beach across from Macedonia community; 03°52'21"S, 070°12'35"W; 68 m elev.; 5.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva, M.P. Valverde leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6679.

Identification. Distinguished from other toothless knifefishes (Hypopomidae + Rhamphichthyidae) by its medium adult body size (270 mm TL), tan base colour with 8–10 irregular pigment bars and over body surface with a notable discontinuity at the lateral line and crescent-shaped pigment patches on anal-fin membrane; a short rounded snout about one-third head length; anal-fin origin anterior to pectoral-fin base; paired supra-pectoral electric organs that extend onto the back of the

head behind the eyes; and paired mental electric organs that extend along the ventral margin of the head.

Type locality. Mouth of the rio Negro, Brazil.

Distribution and habitat. Floodplains and river channels and margins in the Amazon, Orinoco, and Essequibo river basins.

Remarks. Both the light and dark colour morphs of *S. elegans* have been collected from the Tres Fronteras region. Mainly consumes arthropod and fish zooplankton and forms large interspecies schools in the large river channels with other planktivorous gymnotiforms (e.g. *Adontosternarchus* spp. and *Rhabdolichops* spp.).

References. Crampton et al. 2004.

Family Sternopygidae

Distocyclus conirostris (Eigenmann & Allen, 1942)

Figure 8A

New records. COLOMBIA – Amazonas • Sandy beach across from isla de Los Micos; 04°02'32"S, 070°07'15"W; 63 m elev.; 3.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6641 • Shallow area of río Amazonas near isla de Los Micos; 04°03'33"S, 070°06'01"W; 64 m elev.; 3.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6642 • Sandy beach and gramalote patches across from Zaragoza community; 03°55'08"S, 070°11'16"W; 64 m elev.; 5.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva, M.P. Valverde leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6677 • Sandy beach across from Macedonia community; 03°52'21"S, 070°12'35"W; 68 m elev.; 5.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva, M.P. Valverde leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6682.

Identification. Body pinkish white in life, cream to pale yellow when preserved; snout conical; anal-fin rays mostly branched, anal-fin membrane with black distal margin; no caudal fin; caudal appendage sometimes thick and club-like.

Type locality. Iquitos, Peru.

Distribution and habitat. River channels and margins in the lowland Amazon, Orinoco, and Essequibo river basins.

References. Dutra et al. 2014.

Eigenmannia limbata (Schreiner & Miranda Ribeiro, 1903)

Figure 8B

New records. COLOMBIA – Amazonas • Quebrada La Pichuna at confluence with río Amazonas; 04°08'06"S, 070°00'07"W; 68 m elev.; 1.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 2 specimens; CIACOL

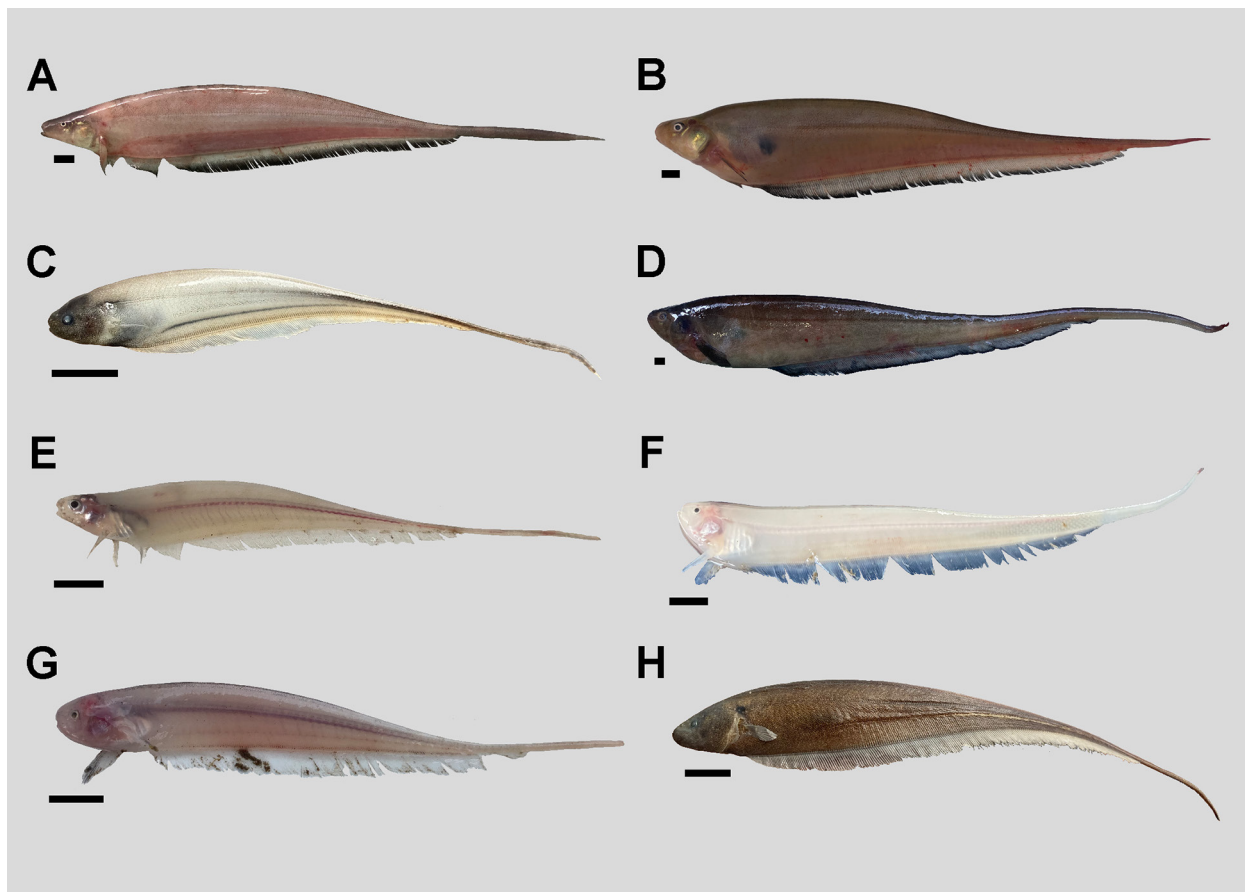


Figure 8. Family Sternopygidae. Scale bars = 1 cm. **A.** *Distocyclus conirostris* CIACOL 6642, 266 mm TL. **B.** *Eigenmannia limbata* CIACOL 6614, 285 mm TL. **C.** *Eigenmannia loreтана* CIACOL 6750, 85 mm TL. **D.** *Eigenmannia nigra* CIACOL 6685, 388 mm TL. **E.** *Eigenmannia cf. macrops* CIACOL 6681, 150 mm TL. **F.** *Rhabdolichops eastwardi* CIACOL 6669, 125 mm TL. Note: dark blue colour of the fins is an artifact of the background of the photograph, the specimen's fins were hyaline in life. **G.** *Rhabdolichops electrogrammus* CIACOL 6656, 104 mm TL. **H.** *Sternopygus macrurus* CIACOL 4915, 134 mm TL.

6610 • Quebrada La Beatriz at confluence with río Amazonas; 04°08'33"S, 069°59'01"W; 68 m elev.; 1.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 3 specimens; CIACOL 6611 • Sandy beaches and patches of gramalote at shore across from Zaragoza community; 03°55'08"S, 070°11'16"W; 64 m elev.; 5.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva, M.P. Valverde leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6665 • Sandy beach and heavily vegetated bank of arm of río Amazonas separating isla Corea from Peru; 04°03'50"S, 070°06'59"W; 64 m elev.; 3.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 2 specimens; CIACOL 6638 • Sandy beach and heavily vegetated bank of arm of río Amazonas separating isla Corea from Peru; 04°03'50"S, 070°07'15"W; 64 m elev.; 3.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 4 specimens; CIACOL 6629 • río Tucuchira approx. 2km from mouth; 04°01'18"S, 070°06'32"W; 70 m elev.; 2.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6614.

Identification. Body large (up to 480 mm TL), opaque, and pearlescent in life with slight countershading, yellow-tan when preserved; body deeper and thicker than sympatric congeners; snout more squared in lateral profile and larger eye than in *E. loreтана*; opercle with golden sheen; distinct black blotch over posterior or ventral portion of body cavity; anal-fin rays mostly branched, anal-fin membrane with black margin; no caudal fin.

Type locality. Amazonas (no exact locality), Brazil.

Distribution and habitat. Apparently widespread in the rivers of the Amazon, Orinoco, and Essequibo river basins. In the western and central Amazon basins, *E. limbata* inhabits whitewater river margins.

References. Maldonado-Ocampo 2011; Waltz 2019.

Eigenmannia loreтана Waltz & Albert, 2018

Figure 8C

New records. COLOMBIA – Amazonas • Brazo quebrada de Yaguaraca, Leticia; 04°08'41"S, 069°55'44"W; 70 m elev.; 27.X.2020; J.D. Bogotá-Gregory leg.; ethanol preservation; 1 specimen; CIACOL 4917 • Finca Agape, km 10.5 vía Leticia-Tarapacá, Quebrada la Arenosa; 04°09'S 69°56'13"W; 77 m. elev.; 23.VII.2022; J.C.

Cárdenas-Campo leg.; ethanol preservation; 1 specimen; CIACOL 6750.

Identification. Body small (up to 250 mm TL) and gracile, semi-translucent in life, lightly pigmented with four dark-grey stripes extending from behind head to tail; head darkly pigmented; fins hyaline; anal-fin rays mostly branched; no caudal fin.

Type locality. Lago Tomana, río Pacaya, Loreto, Peru.

Distribution and habitat. Margins of rivers and streams in the western Amazon.

References. Waltz and Albert 2018.

***Eigenmannia nigra* Mago-Leccia, 1994**

Figure 8D

New record. COLOMBIA – Amazonas • 3rd lake near group of ascerola trees, Lagos Yaguarcaca, Leticia; 04°11'29"S, 069°57'29"W; 60 m elev.; 2.VIII.2022; M.P. Valverde, J. Montalvo leg.; gill net; ethanol preservation; 1 specimen; CIACOL 6685.

Identification. Body large (up to 476 mm TL); head and body uniformly dark brown to black, yellow to brown when preserved with slight countershading; body deeper and thicker than *E. loretana*; black blotch over posterior ventral portion of body cavity; snout short, body slender and with more elongate tail than *E. limbata*; anal-fin rays mostly branched; no caudal fin.

Type locality. Caño Urama, above Santa Lucía, río Negro system, Amazonas, Venezuela.

Distribution and habitat. Rivers and lakes in the Amazon and Orinoco river basins. In the western and central Amazon basins, *E. nigra* inhabits river margins and floodplain oxbow lakes.

Remarks. This record represents a considerable range extension for this species, and the first validated collection in the western Amazon since its original description.

References. Mago-Leccia 1994; Waltz 2019.

Eigenmannia cf. macrops

Figure 8E

New records. COLOMBIA – Amazonas • Along shore of small island across from isla Rondina; 04°10'54"S, 069°59'09"W; 63 m elev.; 1.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6598 • Sandbar east of isla de Los Micos; 04°04'07"S, 070°04'20"W; 64 m elev.; 2.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6625 • Sandy beach and heavily vegetated bank of arm of río Amazonas separating isla Corea from Peru; 04°03'50"S, 070°07'15"W; 64 m elev.; 3.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6628 • Sandy beach and heavily vegetated bank of arm of río Amazonas separating isla Corea from Peru; 04°03'50"S, 070°06'59"W;

64 m elev.; 3.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 2 specimens; CIACOL 6636 • Sandy beach and gramalote patches across from Zaragoza community; 03°55'08"S, 070°11'16"W; 64 m elev.; 5.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva, M.P. Valverde leg.; trawl net; ethanol preservation; 1 specimen, CIACOL 6649; 1 specimen, CIACOL 6653; 1 specimen, CIACOL 6668 • Sandy beach across from Macedonia community; 03°52'21"S, 070°12'35"W; 68 m elev.; 5.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva, M.P. Valverde leg.; trawl net; ethanol preservation; 9 specimens; CIACOL 6681.

Identification. Body transparent with pinkish-cream colour, without black lines or markings in life, pale yellow in preserved specimens; eye large covered with layer of skin; fins hyaline; opercle with silver sheen; anal-fin rays mostly branched; no caudal fin.

Distribution and habitat. River channel and margins of large whitewater rivers in the western Amazon.

Remarks. Likely an undescribed species that is similar in appearance to *E. macrops* from the upper Potaro river drainage in Guyana. This species is seemingly specialized to large river habitats with apparently low tolerance for capture and maintenance in captivity.

References. Waltz 2019.

***Rhabdolichops eastwardi* Lundberg & Mago-Leccia, 1986**

Figure 8F

New records. COLOMBIA – Amazonas • Sandy beaches and patches of gramalote at shore across from Zaragoza community; 03°55'08"S, 070°11'16"W; 64 m elev.; 5.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6669.

Identification. Body semitranslucent, pinkish-cream colour without black lines or markings in life, preserved specimens yellow; superior mouth; eye covered with layer of skin; fins hyaline; deep transparent electric organ visible along the tail.

Type locality. Río Orinoco, old shipping channel south of isla Portuguesa, Delta Amacuro, Venezuela.

Distribution and habitat. River channels and margins of large rivers in the Amazon and Orinoco river basins.

Remarks. This species is seemingly specialized to large river habitats with low tolerance for capture and maintenance in captivity.

References. Lundberg and Mago-Leccia 1986.

***Rhabdolichops electrogrammus* Lundberg & Mago-Leccia, 1986**

Figure 8G

New records. COLOMBIA – Amazonas • Sandy beaches and patches of gramalote at shore across from

Zaragoza community; 03°55'08"S, 070°11'16"W; 64 m elev.; 5.VIII.2022; K.T. Torgersen, R.J. Torgersen, J.J. Potosí-Chuña, W. Quintero-Silva leg.; trawl net; ethanol preservation; 1 specimen; CIACOL 6656.

Identification. Body semitranslucent, pinkish cream colour without black lines or markings and yellow in preserved specimens; terminal mouth; eye covered with layer of skin; fins hyaline; narrow transparent electric organ visible along tail.

Type locality. río Orinoco, near southern shore of caño Araguaíto, Delta Amacuro, Venezuela.

Distribution and habitat. River channels and margins of large rivers in the Amazon and Orinoco river basins.

Remarks. This species is seemingly specialized to large river habitats with low tolerance for capture and maintenance in captivity.

References. Lundberg and Mago-Leccia 1986.

Sternopygus macrurus (Bloch & Schneider, 1801)

Figure 8H

New records. COLOMBIA – Amazonas • Brazo quebrada de Yaguarcaca, Leticia; 04°08'41"S, 069°55'44"W; 70 m elev.; 27.X.2020; J.D. Bogotá-Gregory leg.; ethanol preservation; 2 juveniles; CIACOL 4917 • Madre vieja Mata-Matá, Parque Nacional Natural Amacayacu; 03°48'50"S, 70°15'06"W 78 m elev.; 17.X.2008; C.A. Roa-Fuentes, G. Vela, G. Aricari leg.; ethanol preservation; 1 specimen; CIACOL 441.

Identification. Most often with body of uniform grey-brown colour, but considerable variation is seen across its range; eye free with no skin covering; dark humeral spot behind head; cream or yellow stripe running along partial length of body to end of the tail; all anal-fin rays unbranched.

Type locality. Brazil (no exact locality).

Distribution and habitat. Widespread in most freshwater aquatic habitats from Colombia to Argentina.

Remarks. *Sternopygus macrurus*, as currently recognized, is the most eurytopic and widespread gymnotiform species. Body colour variable by water type ranging from pinkish-white in the upper río Juruá to jet black in the middle río Negro. The considerable variation in colour and body shapes across this species' range may indicate the presence of multiple undescribed species.

References. Hulen et al. 2005; Torgersen and Albert 2022; Torgersen et al. 2023.

Key to the gymnotiforms of the Tres Fronteras region

- 1a Distinct caudal fin with caudal peduncle; dorsal organ present (Family Apterontidae) 2
1b No distinct caudal fin or dorsal organ 14
2a Oral jaws with teeth 3
2b Oral teeth absent in adults; mouth V-shaped

- *Adontosternarchus balaenops*
3a Rictus of mouth extending to, or past, eye 4
3b Rictus not extending to eye 6
4a Shape of mouth square in lateral view; body uniformly gold to black *Parapteronotus hasemani*
4b Mouth not square in lateral view 5
5a Body black with white/cream dorsal stripe; 1–3 light bands at end of tail; scales present on nape ..
..... *Apterontotus albifrons*
5b Body dark, often countershaded; lacking scales on anterior portion of nape *Apterontotus bonapartii*
5c Body pale; inverted L-shaped supratemporal lateralis canals clearly visible behind head
..... *Compsaraia samueli*
6a Snout long, thin, and tubular 7
6b Snout neither tubular nor elongate 10
7a Snout straight; head downturned; mottled grey and black body pigmentation
..... *Platyrosternarchus macrostoma*
7b Snout profile not straight line, neatly countershaded body pigmentation without blotches or mottled pattern 8
8a Snout decurved *Sternarchorhamphus muelleri*
8b Snout highly recurved 9
9a Trunk of snout thick and robust
..... *Sternarchorhynchus mormyrus*
9b Trunk of snout thin and gracile
..... *Sternarchorhynchus cramptoni*
10a Body countershaded, dark along dorsum but lacking pigmentation along the pterygiophores 11
10b Body pink, usually lacking major pigmentation ...
..... 12
11a Snout short and gracile; occasionally with large external tooth pads in terminal males; pectoral fin short *Sternarchogiton nattereri*
11b Snout more elongate; pectoral fin long
..... *Sternarchogiton porcinum*
12a Oral jaws robust 13
12b Oral jaws gracile; body with faint, speckled pattern *Porotergus duende*
13a Mouth superior *Sternarchella calhamazon*
13b Mouth terminal *Sternarchella orthos*
14a Anal fin runs continuous with caudal fin; distinct pitted texture of laterosensory pores on head; adult body size large (>1 m)
..... *Electrophorus multivalvulus*
14b No caudal fin, tail ends in rayless caudal appendage, inconspicuous laterosensory pores on head; adult body size less than 1 m 5
15a Teeth in oral jaws 16
15b No teeth in oral jaws 25
16a Body cylindrical; mouth superior; alternating oblique pigment bands (Family Gymnotidae) 17
16b Body laterally compressed; eye large; no oblique pigment bands (Family Sternopygidae) 18

- 17a Body dark brown to black and with few light bands on posterior end of body; anal fin without black margin *Gymnotus coropinae*
- 17b Pigment bands with irregular margins; anal fin with a black margin
..... *Gymnotus carapo occidentalis*
- 17c H-shaped pigment bands with regular margins on the posterior part of the body; anal fin hyaline
..... *Gymnotus javari*
- 18a Eye without layer of skin; all anal-fin rays unbranched *Sternopygus macrurus*
- 18b Eye covered by layer of skin; most anal-fin rays branched 19
- 19a Snout conical *Distocyclus conirostris*
- 19b Snout blunt 20
- 20a Large electric organ along length of tail 21
- 20b Electric organ on tail small or not visible 22
- 21a Mouth terminal
..... *Rhabdolichops electrogrammus*
- 21b Mouth superior *Rhabdolichops eastwardi*
- 22a Body dark, uniformly dark brown to black
..... *Eigenmannia nigra*
- 22b Body pale to translucent 23
- 23a Dark humeral blotch on lateral surface behind head; fin margins black *Eigenmannia limbata*
- 23b No dark blotch on body, fins hyaline without noticeably dark margins 24
- 24a Three black lateral stripes along lateral body surface *Eigenmannia loreтана*
- 24b No black stripes or markings along lateral body surface *Eigenmannia cf. macrops*
- 25a Anal fin origin at or in advance of pectoral-fin base (Family Rhamphichthyidae) 26
- 25b Anal fin origin posterior to pectoral-fin base (Family Hypopomidae) 30
- 26a Body elongate; snout trumpet-like 27
- 26b Body short, snout blunt 29
- 27a Body semitranslucent and with black markings or saddles *Gymnorhamphichthys rondoni*
- 27b Body opaque, dark with mottled or saddled pigment marking 28
- 28a Trumpet-snout robust and relatively short; body deep *Rhamphichthys pantherinus*
- 28b Trumpet-snout gracile and relatively long; body shallow *Rhamphichthys rostratus*
- 29a Dark vertical pigment bars along body; paired mental electric organs *Steatogenys elegans*
- 29b Dark vertical pigment bars along body; paired supra-pectoral electric organs extending to back of head behind eyes *Hypopygus lepturus*
- 30a Large electric organ readily visible in lateral profile on posterior third of body, with six columns of electrocytes above the posterior end of the anal fin; light-brown base with many dark saddles
..... *Brachyhypopomus bennetti*

- 30b Electric organ on tail not readily visible; light-tan body with irregularly scattered dark spotted pigment patches *Brachyhypopomus sullivanii*

Discussion

This work represents the first gymnotiform-targeted regional survey in the Amazon basin. It highlights the high phenotypic and taxonomic diversity of these fishes in the lowland western Amazon. However, the geographic ranges and taxonomic limits of many species remain poorly understood, largely due to limited sampling and the relatively few experts working with the group. Most major gymnotiform data from the western and central Amazon have been collected in the vicinity of Iquitos (Peru) and Tefé and Manaus (Brazil). The Tres Fronteras represented a large gap in the sampling of gymnotiforms along the length of the Amazon river. Although the presence of 33 species has been validated from this region, an additional 27 species are expected based on known occurrences further upstream and downstream; however, they have not yet been recorded in between near Leticia (Table 3). We suggest several reasons for this discrepancy, including the possibility of naturally disjunct distributions or adult modal localities or breeding sites, an incomplete taxonomy of the fauna resulting in inaccurate ranges of species, or incomplete sampling of the region.

We also report on intraspecific phenotypic diversity within several gymnotiform species collected in the Tres Fronteras region, including *Parapteronotus hasemani*, *Sternarchorhamphus muelleri*, and *Steatogenys elegans* (Fig. 9). Individuals of *P. hasemani* were previously known to present shades of brown to black, but here we record an individual with bright-orange colouration and report that specimens of all pigment varieties are present in the same region, perhaps suggesting that there is not population structure of body colour in this species. *Parapteronotus hasemani* is known to display sexual dimorphism of the head, with males developing elongated oral jaws; however, there is no indication the diversity of colour is sexually dimorphic as well, as no dimorphic males were collected and a gradation of colour patterns were observed. *Sternarchorhamphus* is a monotypic genus which varies in colour from dark purple to pinkish white. Specimens with dark and moderate colouration were collected together in the main channel of the Amazon. One specimen (CIACOL 6621) markedly changed colour from medium grey to pinkish-white approximately 45 minutes after capture, which suggests that external pigmentation may reflect stress or condition of the animal. Additionally, we report the collection of both light and dark morphs of *Steatogenys elegans* from the same stretch of the whitewater Amazon channel. This species is highly variable in colour pattern across its range, and this is thought to be due to water type or the presence of cryptic species (Cooke et al. 2014). The taxonomic status of these colour morphs is currently unknown, but our

Table 3. List of gymnotiform species expected, but not yet reported from the Tres Fronteras region. Habitat abbreviations for multiple habitats include river channel (RC), terra firme (TF), and floodplain (FP).

| Family | Species | Habitat | Reference |
|------------------|--|---------------|---------------------------------|
| Apteronotidae | <i>Adontosternarchus clarkae</i> | River channel | Mago-Leccia et al. 1985 |
| Apteronotidae | <i>Adontosternarchus nebulosus</i> | River channel | Lundberg and Cox-Fernandes 2007 |
| Apteronotidae | <i>Adontosternarchus sachi</i> | River channel | Mago-Leccia et al. 1985 |
| Apteronotidae | <i>Orthosternarchus tamandua</i> | River channel | Hilton et al. 2007 |
| Apteronotidae | <i>Pariosternarchus amazonensis</i> | River channel | Albert and Crampton 2006 |
| Apteronotidae | <i>Porotergus gimbeli</i> | River channel | De Santana and Crampton 2010 |
| Apteronotidae | <i>Sternarchella ducis</i> | River channel | Evans et al. 2017 |
| Apteronotidae | <i>Sternarchella raptor</i> | River channel | Evans et al. 2017 |
| Apteronotidae | <i>Sternarchella rex</i> | River channel | Evans et al. 2017 |
| Apteronotidae | <i>Sternarchella schotti</i> | River channel | Evans et al. 2017 |
| Apteronotidae | <i>Sternarchogiton labiatus</i> | River channel | De Santana and Crampton 2007 |
| Apteronotidae | <i>Sternarchorhynchus curvirostris</i> | River channel | De Santana and Vari 2010 |
| Apteronotidae | <i>Sternarchorhynchus goeldii</i> | River channel | De Santana and Vari 2010 |
| Gymnotidae | <i>Gymnotus curupira</i> | Terra firme | Crampton et al. 2005 |
| Gymnotidae | <i>Gymnotus obscurus</i> | Floodplain | Crampton et al. 2005 |
| Gymnotidae | <i>Gymnotus varzea</i> | Floodplain | Crampton et al. 2005 |
| Hypopomidae | <i>Brachyhypopomus beebei</i> | FP + TF | Crampton et al. 2016 |
| Hypopomidae | <i>Brachyhypopomus brevirostris</i> | FP + TF | Crampton et al. 2016 |
| Hypopomidae | <i>Brachyhypopomus flavipomus</i> | Floodplain | Crampton et al. 2016 |
| Hypopomidae | <i>Brachyhypopomus hamiltoni</i> | Floodplain | Crampton et al. 2016 |
| Hypopomidae | <i>Brachyhypopomus regani</i> | FP + TF | Crampton et al. 2016 |
| Hypopomidae | <i>Brachyhypopomus walteri</i> | FP + TF | Crampton et al. 2016 |
| Rhamphichthyidae | <i>Gymnorhamphichthys bogardusae</i> | Rc + FP + TF | Carvalho 2013 |
| Rhamphichthyidae | <i>Gymnorhamphichthys hypopostomus</i> | Rc + FP + TF | Carvalho 2013 |
| Rhamphichthyidae | <i>Steatogenys ocellatus</i> | Floodplain | Bogotá-Gregory et al. 2018 |
| Sternopygidae | <i>Rhabdolichops caviceps</i> | River channel | Correa et al. 2006 |
| Sternopygidae | <i>Rhabdolichops troscheli</i> | River channel | Correa et al. 2006 |

brief examination of the specimens was unable to find additional morphological characters to separate them as distinct species.

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Methodology: JSA, KTT. Project administration: KTT. Resources: JDBG, AAS, EAC, JPC. Supervision: EAC, JSA. Validation: JDBG. Visualization: KTT. Writing – original draft: KTT, JSA. Writing – review and editing: JDBG, JSA, KTT.

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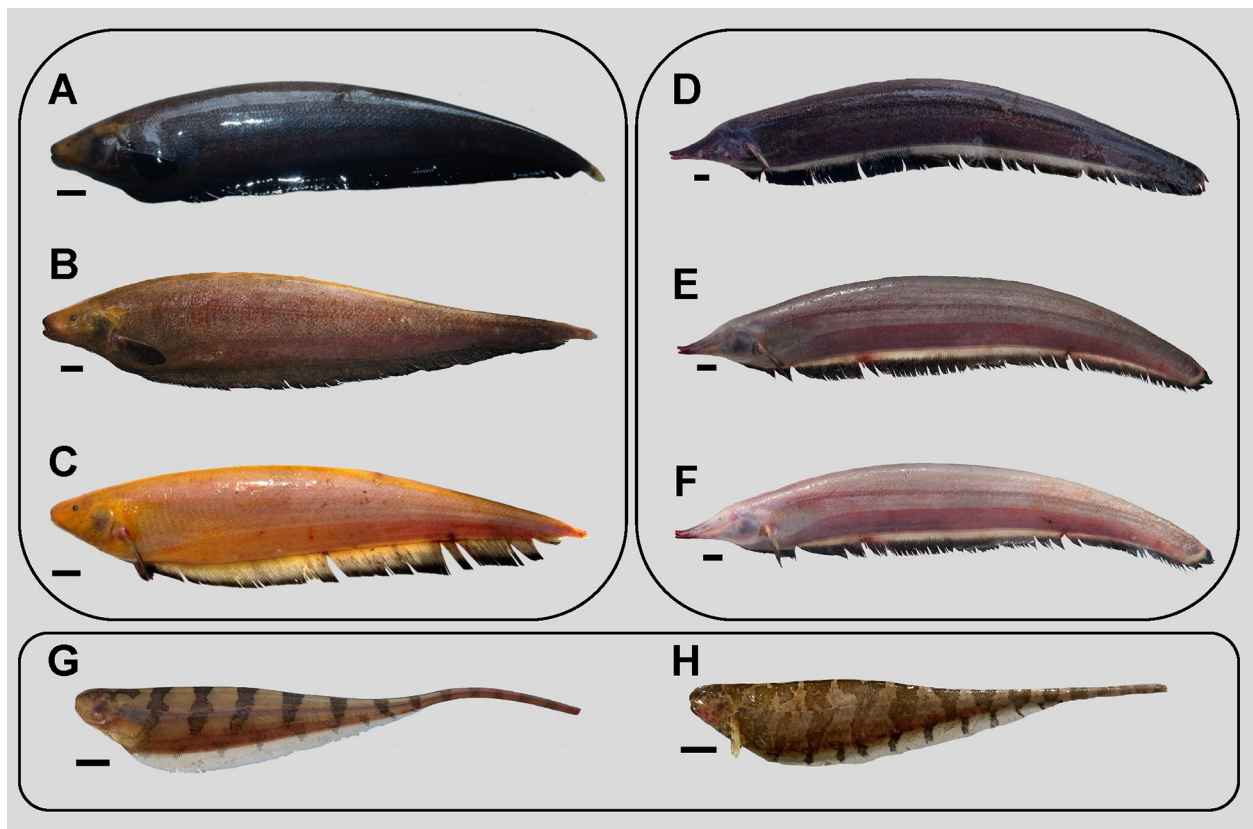


Figure 9. Color morphs of three variable species of gymnotiform knifefishes collected by the authors in the Tres Fronteras region. **A.** *Parapteronotus hasemani* black pigmentation CIACOL 6690, 288 mm TL. **B.** *Parapteronotus hasemani* intermediate pigmentation CIACOL 6620, 245 mm TL. **C.** *Parapteronotus hasemani* gold/orange pigmentation CIACOL 6674, 170 mm TL. **D.** *Sternarchorhamphus muelleri* dark pigmentation CIACOL 6658, 362 mm TL. **E.** *Sternarchorhamphus muelleri* intermediate pigmentation immediately after collection CIACOL 6621, 335 mm TL. **F.** *Sternarchorhamphus muelleri* same specimen as in **E.** but approximately 45 min. after collection. **G.** *Steatogenys elegans* light morph CIACOL 6606, 146 mm TL. **H.** *Steatogenys elegans* dark morph CIACOL 6679, 130 mm TL.

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