

# Fishes of the Grijalva River basin of Mexico and Guatemala

Adán Enrique Gómez-González<sup>1,2\*</sup>, Ernesto Velázquez-Velázquez<sup>1</sup>, Manuel de Jesús Anzueto Calvo<sup>1</sup> and Maritza Fabiola Maza-Cruz<sup>1</sup>

1 Museo de Zoología, Instituto de Ciencias Biológicas, Universidad de Ciencias y Artes de Chiapas. Libramiento Norte Poniente No. 1150, Colonia Lajas Maciel, C.P. 29039. Tuxtla Gutiérrez, Chiapas, Mexico

2 Posgrado en Ciencias Biológicas, Instituto de Biología, Universidad Nacional Autónoma de México; Tercer circuito s/n, Ciudad Universitaria, Copilco, Coyoacán. A.P. 70-153, C.P. 04510, Distrito Federal, Mexico

\* Corresponding author. E-mail: [aegomezglez@gmail.com](mailto:aegomezglez@gmail.com)

**Abstract:** The Grijalva River basin is one of the largest hydrological systems in Central America. Despite its importance, an inventory of its ichthyofauna remains incomplete. We provide a systematic checklist of fishes recorded in the Grijalva River basin based on surveys performed from 2002 to 2015. The systematic list includes 92 species, belonging to 13 orders, 25 families and 50 genera, of which 83 species are native and nine are exotics. This checklist includes three range expansions (*Profundulus hildebrandi*, *Poecilia sphenops* and *Paraneotroplus hartwegi*). Fifteen species are endemic to the basin. The most diverse families are Cichlidae and Poeciliidae with 25 and 23 species, respectively. Secondary freshwater fish diversity is high with 65.1%, the remaining species are primary freshwater (13.3%) and peripheral (21.7%) fishes.

**Key words:** Central America, Grijalva-Usumacinta basin, ichthyofauna, diversity, endemism

## INTRODUCTION

The Grijalva-Usumacinta basin is the largest river system in Central America and it is considered a hotspot of biodiversity (Hudson et al. 2005). In Mexico, although the drainage represents only 4.7% of the total surface area, its ecosystems contain 64% of all biodiversity (Toledo 2003). The Grijalva River basin has been severely modified due to damming, and this is one of the major threats to the fish fauna. In addition, water pollution, siltation, overfishing, and introduction of exotic fishes continues to threaten fishes of this region.

Although the Grijalva River has high species richness and high levels of endemism (Rodiles-Hernández 2005; Velázquez-Velázquez et al. 2013), species composition lists remain incomplete and are restricted to smaller geographic areas, mostly near dams and protected areas (e.g., Bueno-Soria and Santiago-Fragoso 2002;

Olmos-Tomasini 2002; Pérez et al. 2002; Rodiles-Hernández 2005; González-Díaz et al. 2008). The aim of this study was to describe the composition and distribution of the ichthyofauna throughout the entire Grijalva River basin.

## MATERIALS AND METHODS

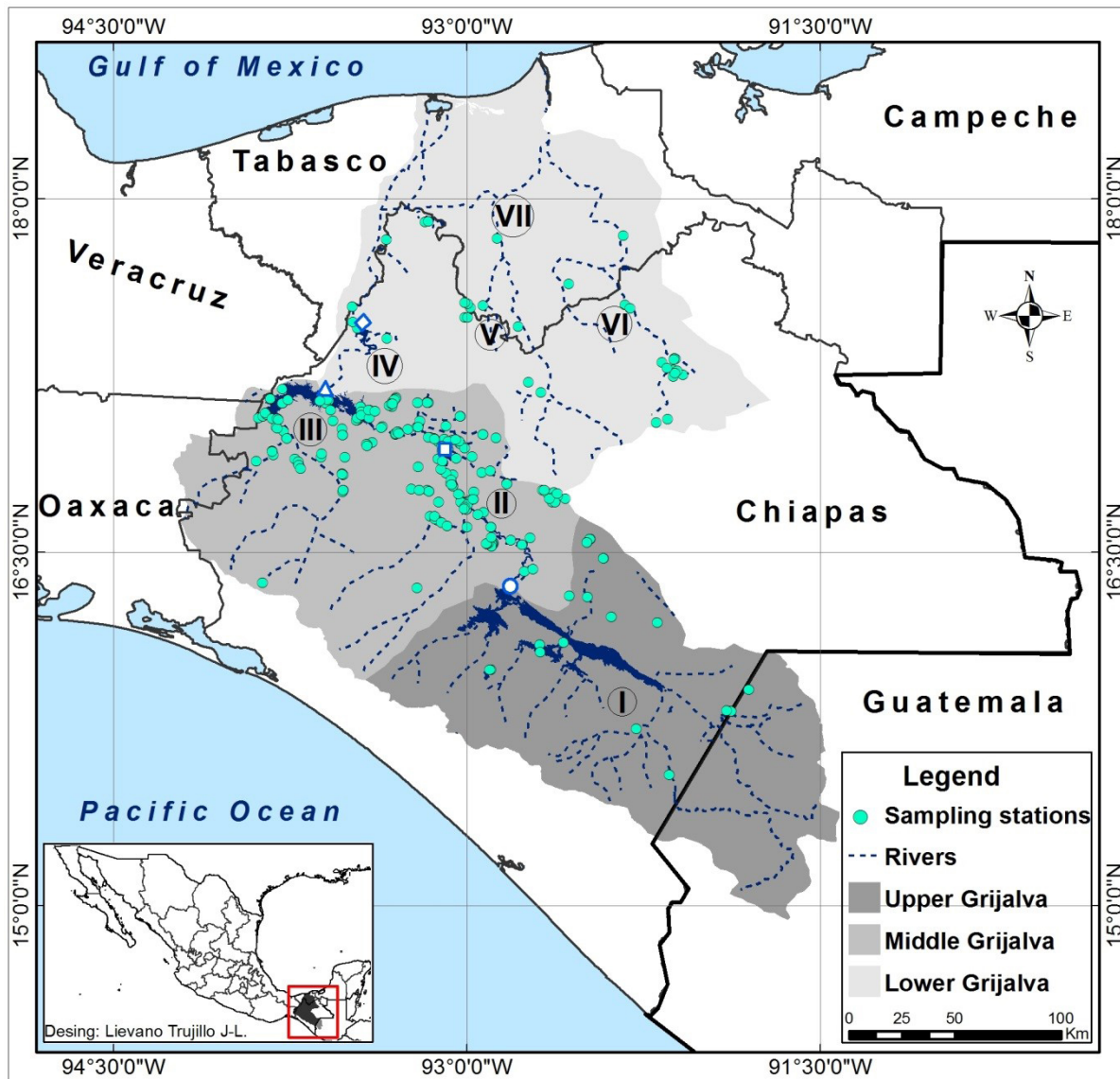
### Study area

The Grijalva River is located in southern Mexico and northwestern Guatemala. Together with the Usumacinta River, it is the most voluminous river system in Mesoamerica (Tamayo and West 1964). The Grijalva River basin covers an area of 58,000 km<sup>2</sup>, of which 9% are in the upper reaches of the Sierra de los Cuchumatanes, Guatemala and the remaining portion in Mexico, throughout the states of Chiapas, Tabasco, and small portions of Oaxaca and Veracruz, until it joins with the Usumacinta River and drains into the Gulf of Mexico (Hudson et al. 2005; García-García 2011; Figure 1).

The Grijalva River basin is divided in three hydrological regions: Upper Grijalva or Grijalva-La Concordia, Middle Grijalva or Grijalva-Tuxtla Gutiérrez and Lower Grijalva or Grijalva-Villahermosa (SEMARNAT 2010a; Figure 1). In the state of Chiapas, the main channel of the river has been highly modified due to the construction of four large hydroelectric dams: Belisario Domínguez or La Angostura, Manuel Moreno Torres or Chicoasén, Nezahualcóyotl or Malpaso, and Ángel Albino Corzo or Peñitas (Figure 1).

### Fish sampling

More than 200 sampling stations were surveyed throughout the Grijalva River basin since 2002 (Figure 1). The bodies of water sampled included streams, lagoons, points along the main river channel, near dams, as well as underground waters, that were selected to maximize the diversity of the sampled environments in order to represent the complete composition of the



**Figure 1.** Location of the Grijalva River basin and sampling stations. Sections are numbered and named as follows: I La Angostura, II Chicoasén, III Malpaso, IV Peñitas, V Teapa-Tacotalpa, VI Tulijá-Macuspána, VII Tabascal plain. Figures indicates the Hydroelectric Power Stations: Belisario Domínguez or La Angostura reservoir (circle), Manuel Moreno Torres or Chicoasén reservoir (square), Nezahualcōyotl or Malpaso reservoir (triangle) and Ángel Albino Corzo or Peñitas reservoir (rhombus).

basin's fish fauna. Fish were captured using gill nets, dip nets, cast nets, trawl nets, minnow traps, line and hook, backpack electrofishers, and complementary samples from local fishermen. The specimens were fixed in a 10% formalin solution and then preserved in 70% ethanol. The samples were deposited at the Museo de Zoología of the Universidad de Ciencias y Artes de Chiapas (UNICACH; see Appendix 1). Fish were collected with research permits (SGPA/DGVS/03479/09, SGPA/DGVS/02208/13) provided by Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT). In order to complement the inventory, literature records were also obtained from Lozano-Vilano and Contreras Balderas (1987), Rodiles-Hernández (2005), and Espinosa-Pérez and Daza-Zepeda (2005), as well as by querying the online inter-institutional database FishNet2 (<http://www.fishnet2.net>).

Fish were identified with the taxonomic keys of Álvarez (1971), Castro-Aguirre et al. (1999) and Miller et al. (2005); original descriptions and recent systematic revisions were also employed. The checklist is arranged by order and family following Nelson (2006); valid species names, authorities and year of publication follow Eschmeyer (2015); genera and species within families are arranged in alphabetical order. Ecological species affinity accord to salinity tolerance was based on Myers (1938). The risk category is based on Mexican law NOM-059-SEMARNAT-2010 (SEMARNAT 2010b).

Distributional data were obtained by subdivision of the hydrological regions and their tributaries in the basin, based on the presence of the four hydroelectrical dams; also, the physiographic features of the lower Grijalva allow it to be divided in three additional subregions (Tamayo and West 1964): Teapa-Tacotalpa

and Tulijá-Macuspana systems in the North highlands of Chiapas and Tabascal Plain in the lowlands (Figure 1).

## RESULTS

The fish fauna of the Grijalva River basin is composed by 92 species, belonging to 13 orders, 25 families and 50 genera, of which 83 species are native and nine are exotics. From the total, 77 species are deposited in our vouchers and 15 are literature records. The orders Perciformes and Cyprinodontiformes are the most diverse groups, with 36 and 28 species, respectively (Table 1), both representing 69.6% of the total richness. Cichlidae is the most diverse family, with 25 species (30.1% of total richness, not including exotics), followed by Poeciliidae with 23 (27.7% of total richness; Table 2).

Based on ecological affinity, 11 (13.3%) species are primary, 54 (65.1%) secondary and 18 (21.7%) peripheral, of which 11 are vicarious, two of estuarine affinity, four euryhaline marines and one catadromous; the rest are exotics. Fifteen species are considered endemic to the basin: *Rhamdia laluchensis*, *R. macuspanensis*, *Profundulus candalarius*, *P. hildebrandi*, *Gambusia eurystoma*, *Heterophallus milleri*, *Poeciliopsis hnlickai*, *Poecilia sulphuraria*, *P. thermalis*, *Priapella chamulae*, *Cichlasoma grammodes*, *Paraneetroplus breidohri*, *P. gibbiceps*, *P. hartwegi*, and *Thorichthys socolofi*. Thirteen species are in the Mexican endangered species list (NOM-059-SEMARNAT-2010): *P. hildebrandi* and *P. sulphuraria* as endangered; *R. macuspanensis*, *Priapella compressa*, *Xiphophorus clemenciae*, *P. hartwegi* and *T. socolofi* as threatened; *Potamarius nelsoni*, *Rhamdia guatemalensis*, *G. eurystoma*, *Priapella intermedia*, *C. grammodes*, and *Theraps intermedius* as special protection (Table 2).

**Table 1.** Taxonomic composition of the ichthyofauna of the Grijalva River basin. Names in bold indicate the most diverse taxa.

Order	Family	Genera	Species
Lepisosteiformes	1	1	1
Elopiformes	1	1	1
Clupeiformes	2	2	3
Cypriniformes	2	3	3
Characiformes	1	4	4
<b>Siluriformes</b>	<b>4</b>	<b>5</b>	<b>8</b>
Batrachoidiformes	1	1	1
Mugiliformes	1	2	2
Beloniformes	2	2	2
<b>Cyprinodontiformes</b>	<b>3</b>	<b>12</b>	<b>28</b>
Synbranchiformes	1	1	1
<b>Perciformes</b>	<b>5</b>	<b>15</b>	<b>36</b>
<b>Total</b>	<b>25</b>	<b>50</b>	<b>92</b>

The most diverse regions are found in the Lower Grijalva. The Tabascal plain has the highest richness (60 species), followed by the systems Tulijá-Macuspana (56) and Teapa-Tacotalpa (55; Table 2). The most widely distributed species are *Astyanax aeneus*, *Atherinella alvarezii*, *Brycon guatemalensis*, *Dorosoma anale*, *Ictalurus meridionalis*, *Ophisternon aenigmaticum*, *Rhamdia guatemalensis*, and the exotic *Oreochromis niloticus*, which are found throughout the basin.

## DISCUSSION

The Grijalva River basin together with the Usumacinta are included within the Usumacinta ichthyological province (*sensu* Miller 1966, but see Matamoros et al. 2015), which shows the highest levels of freshwater fish diversity and endemism in Central America (Miller 1966; Myers 1966; Bussing 1998; Matamoros

**Table 2.** Systematic checklist of fishes of the Grijalva River basin. Risk categories are accord to the Mexican law (NOM-059-SEMARNAT-2010): Pr (Under special protection), T (Threatened), E (Endangered). Ecological classification: P (Primary freshwater), S (Secondary freshwater), Pe (Peripheral), V (Vicarious), Ca (Catadromous), Es (Estuarine affinity), ME (Marine Euryhaline). (\*) endemic species, (Ex) exotic species, (LR) literature record. The "x" indicate the presence of the species in the regions.

Taxa	Risk category	Ecological classification	Grijalva River regions						
			La Angostura	Chicoasén	Malpaso	Peñitas	Teapa-Tacotalpa	Tulijá-Macuspana	Tabascal Plain
<b>Order Lepisosteiformes</b>									
I Family Lepisosteidae									
1	<i>Atractosteus tropicus</i> Gill, 1836	DP							x
<b>Order Elopiformes</b>									
II Family Megalopidae									
2	<i>Megalops atlanticus</i> Valenciennes, 1847	Pe (ME)							x
<b>Order Clupeiformes</b>									
III Family Engraulidae									
3	<i>Anchoa mitchilli</i> (Valenciennes, 1848) LR	Pe (ME)							x
IV Family Clupeidae									
4	<i>Dorosoma anale</i> Meek, 1904	Pe (V)	x	x	x	x	x	x	x
5	<i>Dorosoma petenense</i> (Günther, 1867)	Pe (V)		x	x	x	x	x	x
<b>Order Cypriniformes</b>									
V Family Catostomidae									
6	<i>Ictiobus meridionalis</i> (Günther, 1868) LR	DP			x	x	x	x	x

Continued

Table 2. Continued.

Taxa	Risk category	Ecological classification	Grijalva River regions						
			La Angostura	Chicoasén	Malpaso	Peñitas	Teapa-Tacotalpa	Tulijá-Macuspána	Tabascal Plain
<b>VI Family Cyprinidae</b>									
7 <i>Cyprinus carpio</i> Linnaeus, 1758 <sup>Ex</sup>		-	x	x				x	
8 <i>Ctenopharyngodon idella</i> (Valenciennes, 1844) <sup>Ex</sup>		-					x	x	x
<b>Order Characiformes</b>									
<b>VII Family Characidae</b>									
9 <i>Astyanax aeneus</i> (Günther, 1860)		DP	x	x	x	x	x	x	x
10 <i>Bramocharax</i> sp.		DP						x	
11 <i>Brycon guatemalensis</i> Regan, 1908		DP	x	x	x	x	x	x	x
12 <i>Hyphessobrycon compressus</i> (Meek, 1904) <sup>LR</sup>		DP					x	x	x
<b>Order Siluriformes</b>									
<b>VIII Family Ictaluridae</b>									
13 <i>Ictalurus meridionalis</i> (Günther, 1864)		DP	x	x	x	x	x	x	x
<b>IX Family Ariidae</b>									
14 <i>Cathorops kailolae</i> Marceniuk & Betancur-R., 2008		Pe (V)		x	x	x	x	x	x
15 <i>Potamarius nelsoni</i> (Evermann & Goldsborough, 1902)	Pr	Pe (V)			x	x	x	x	x
<b>X Family Heptapteridae</b>									
16 <i>Rhamdia laluchensis</i> Weber, Allegrucci & Sbordoni, 2003 <sup>*</sup>		DP			x				
17 <i>Rhamdia laticauda</i> (Kner, 1858)		DP			x	x	x	x	x
18 <i>Rhamdia guatemalensis</i> (Günther, 1864)	Pr	DP	x	x	x	x	x	x	x
19 <i>Rhamdia macuspanensis</i> Weber & Wilkens, 1989 <sup>*</sup>	T	DP						x	
<b>XXV Family Loricariidae</b>									
20 <i>Pterygoplichthys</i> spp. <sup>Ex</sup>							x	x	x
<b>Order Batrachoidiformes</b>									
<b>XI Family Batrachoididae</b>									
21 <i>Batrachoides goldmani</i> Evermann & Goldsborough, 1902		Pe (V)			x	x	x	x	x
<b>Order Mugiliformes</b>									
<b>XII Family Mugilidae</b>									
22 <i>Agonostomus monticola</i> (Bancroft, 1834) <sup>LR</sup>		Pe (Ca)					x	x	
23 <i>Mugil curema</i> Valenciennes, 1836 <sup>LR</sup>		Pe (ME)							x
<b>Order Atheriniformes</b>									
<b>XIII Family Atherinopsidae</b>									
24 <i>Atherinella alvarezii</i> (Díaz-Pardo, 1972)		Pe (V)	x	x	x	x	x	x	x
25 <i>Atherinella schultzi</i> (Álvarez & Carranza, 1952) <sup>LR</sup>		Pe (V)					x	x	x
<b>Order Beloniformes</b>									
<b>XIV Family Belonidae</b>									
26 <i>Strongylura hubbsi</i> Collette, 1974		Pe (V)			x	x	x	x	x
<b>XV Family Hemiramphidae</b>									
27 <i>Hyporhamphus mexicanus</i> Álvarez, 1959		Pe (V)			x	x	x	x	x
<b>Order Cyprinodontiformes</b>									
<b>XVI Family Rivulidae</b>									
28 <i>Cynodonichthys tenuis</i> Meek, 1904		DS					x	x	x
<b>XVII Family Profundulidae</b>									
29 <i>Profundulus candalarius</i> Hubbs, 1924 <sup>*</sup>		DS	x						
30 <i>Profundulus hildebrandi</i> Miller, 1950 <sup>*</sup>	E	DS					x		
31 <i>Profundulus labialis</i> (Günther, 1866)		DS	x	x	x	x	x	x	
32 <i>Profundulus punctatus</i> (Günther, 1866)		DS		x	x				
<b>XVIII Family Poeciliidae</b>									
33 <i>Belonesox belizanus</i> Kner, 1860		DS					x	x	x
34 <i>Carlhubbsia kidderi</i> (Hubbs, 1936)		DS							x
35 <i>Gambusia eurystoma</i> Miller, 1975 <sup>*</sup>	Pr	DS					x		
36 <i>Gambusia sexradiata</i> Hubbs, 1936		DS		x	x	x	x	x	x
37 <i>Gambusia yucatana</i> Regan, 1914		DS			x	x			x
38 <i>Heterophallus echeagarayi</i> Álvarez, 1952		DS					x	x	x
39 <i>Heterophallus milleri</i> (Radda, 1987) <sup>* LR</sup>		DS					x		x
40 <i>Phallichthys fairweatheri</i> Rosen & Bailey, 1959 <sup>LR</sup>		DS							x
41 <i>Poeciliopsis fasciata</i> (Meek, 1904)		DS	x	x	x				
42 <i>Poeciliopsis hniliickai</i> Meyer & Vogel, 1981 <sup>*</sup>		DS	x	x	x				
43 <i>Poeciliopsis pleurospilus</i> (Günther, 1866)		DS	x	x	x	x			
44 <i>Poecilia petenensis</i> Günther, 1866 <sup>LR</sup>		DS						x	x

Continued



Table 2. Continued.

Taxa	Risk category	Ecological classification	Grijalva River regions						
			La Angostura	Chicoasén	Malpaso	Peñitas	Teapa-Tacotalpa	Tulijá-Macuspána	Tabascal Plain
45 <i>Poecilia mexicana</i> Steindachner, 1863		DS			x	x	x	x	x
46 <i>Poecilia sphenops</i> Valenciennes, 1846		DS	x	x	x		x	x	
47 <i>Poecilia sulphuraria</i> Álvarez, 1948 *	P	DS					x		
48 <i>Poecilia thermalis</i> Steindachner, 1863 * <sup>LR</sup>		DS					x		
49 <i>Priapella compressa</i> Álvarez, 1948	T	DS						x	
50 <i>Priapella intermedia</i> Álvarez & Carranza, 1952	Pr	DS			x				
51 <i>Priapella chamulae</i> Schartl, Meyer & Wilde, 2006 *		DS					x		
52 <i>Pseudoxiphophorus bimaculatus</i> (Heckel, 1848)		DS			x	x	x	x	
53 <i>Xiphophorus clemenciae</i> Álvarez, 1959	T	DS			x				
54 <i>Xiphophorus hellerii</i> Heckel, 1848		DS			x	x	x	x	x
55 <i>Xiphophorus maculatus</i> (Günther, 1866)		DS					x	x	x
<b>Order Synbranchiformes</b>									
XIX Family Synbranchidae									
56 <i>Ophisternon aenigmaticum</i> Rosen & Greenwood, 1976		DS	x	x	x	x	x	x	x
<b>Order Perciformes</b>									
XX Family Centropomidae									
57 <i>Centropomus undecimalis</i> (Bloch, 1792)		Pe (ME)							x
XXI Family Gerreidae									
58 <i>Eugerres mexicanus</i> (Steindachner, 1863)		Pe (V)		x	x	x	x	x	x
XXII Family Sciaenidae									
59 <i>Aplodinotus grunniens</i> Rafinesque, 1819		Pe (V)		x	x	x	x	x	
XXIII Family Cichlidae									
60 <i>Amphilophus macracanthus</i> (Günther, 1864)		DS	x		x				
61 <i>Amphilophus robertsoni</i> Regan, 1905 <sup>LR</sup>		DS					x	x	x
62 <i>Cichlasoma grammodes</i> Taylor & Miller, 1980 *	Pr	DS	x	x					
63 <i>Cichlasoma salvini</i> (Günther, 1862)		DS			x	x	x	x	x
64 <i>Cichlasoma trimaculatum</i> (Günther, 1867)		DS		x	x				
65 <i>Cichlasoma urophthalmus</i> (Günther, 1862)		DS			x	x	x	x	x
66 <i>Oreochromis aureus</i> (Steindachner, 1864) <sup>ExLR</sup>		-							x
67 <i>Oreochromis mossambicus</i> (Peters, 1852) <sup>Ex</sup>		-	x		x				
68 <i>Oreochromis niloticus</i> (Linnaeus, 1758) <sup>Ex</sup>		-	x	x	x	x	x	x	x
69 <i>Parachromis friedrichsthalii</i> (Heckel, 1840) <sup>LR</sup>		DS							x
70 <i>Parachromis managuensis</i> (Günther, 1867) <sup>Ex</sup>		-		x	x	x	x	x	x
71 <i>Parachromis motaguensis</i> (Günther, 1867) <sup>ExLR</sup>		-					x		x
72 <i>Paraneetroplus argenteus</i> (Allgayer, 1991)		DS						x	x
73 <i>Paraneetroplus bifasciatus</i> (Steindachner, 1864)		DS					x	x	x
74 <i>Paraneetroplus breidohri</i> (Werner & Stawikowski, 1987) *		DS	x						
75 <i>Paraneetroplus fenestratus</i> (Günther, 1860)		DS							x
76 <i>Paraneetroplus gibbiceps</i> (Steindachner, 1864) *		DS					x	x	
77 <i>Paraneetroplus hartwegi</i> (Taylor & Miller, 1980) *	T	DS	x	x	x	x			x
78 <i>Paraneetroplus regani</i> (Miller, 1974)		DS		x	x				
79 <i>Paraneetroplus melanurus</i> (Günther, 1862)		DS		x	x	x	x	x	x
80 <i>Petenia splendida</i> Günther, 1862		DS		x	x	x	x	x	x
81 <i>Rocio octofasciata</i> (Regan, 1903)		DS					x	x	x
82 <i>Theraps heterospilus</i> (Hubbs, 1936)		DS						x	x
83 <i>Theraps intermedius</i> (Günther, 1862)	Pr	DS					x	x	x
84 <i>Theraps lentiginosus</i> (Steindachner, 1864)		DS					x	x	
85 <i>Theraps pearsei</i> (Hubbs, 1936)		DS		x	x	x	x	x	x
86 <i>Thorichthys helleri</i> (Steindachner, 1864)		DS			x	x	x	x	x
87 <i>Thorichthys meeki</i> (Brind, 1918)		DS					x	x	x
88 <i>Thorichthys pasionis</i> Rivas, 1862		DS						x	x
89 <i>Thorichthys socolofi</i> (Miller & Taylor, 1984) *	T	DS						x	
90 <i>Tilapia zillii</i> (Gervais, 1848) <sup>Ex</sup>		-	x	x	x				
XXIV Family Eleotridae									
91 <i>Dormitator maculatus</i> (Bloch, 1972) <sup>LR</sup>		Pe (E)							x
92 <i>Gobiomorus dormitor</i> Lacépède, 1800		Pe (E)					x		X
<b>Total species by region</b>			<b>21</b>	<b>29</b>	<b>45</b>	<b>34</b>	<b>55</b>	<b>56</b>	<b>60</b>

et al. 2015). Miller et al. (2005) recognized nearly 200 species in this province, and 115 species throughout the complete Grijalva-Usumacinta basin. This highlights the great diversity in the Grijalva basin, which comprises almost half of the total richness of this province. The high diversity found in this region is due to a complex geological history and the recent connections between the Grijalva River and adjacent basins (González-Díaz et al. 2008). As a result, some species are restricted to particular habitats; *Rhamdia laluchensis* and *R. macuspanensis* that are stygobitic, and several species of poeciliids inhabit in sulphidic ambients, as *Poecilia sulphuraria*, *P. thermalis* and *Gambusia eurystoma*.

Despite its importance, the Grijalva River basin has not received substantial study. As a result, several new species have been discovered in the basin in the last 35 years, such as *Paraneetroplus hartwegi* (Taylor & Miller, 1980), *Cichlasoma grammodes* Taylor & Miller, 1980, *Poeciliopsis hnlickai* Meyer & Vogel, 1981, *Thorichthys socolofi* Miller & Taylor, 1984, *Heterophallus milleri* (Radda, 1987), *Paraneetroplus breidohri* (Werner & Stawikowski, 1987), *Rhamdia macuspanensis* Weber & Wilkens, 1998, *Rhamdia laluchensis* Weber, Allegrucci & Sbordoni, 2003, and *Priapella chamulae* Schartl, Meyer & Wilde, 2006; also recently, some species previously considered endemics to the Coatzacoalcos river basin have been recorded in the middle section of the Grijalva basin, including *Paraneetroplus regani*, *Priapella intermedia*, and *Xiphophorus clemenciae* (González-Díaz et al. 2008; Gómez-González et al. 2014). Also, some cichlids, such as *Amphilophus macracanthus* and *Cichlasoma trimaculatum*, formerly only known in the Pacific drainage, have shown up in the Grijalva, although apparently the latter for both may be a recent translocation (Miller et al. 2005).

Recently, we discovered another population of the San Cristóbal Pupfish (*Profundulus hildebrandi*) in the upper reaches of the Teapa-Tacotalpa system, in the municipalities of San Juan Chamula and Chenalhó, Chiapas. This species is considered microendemic; its habitat is being encroached upon by urban growth in the Valley of San Cristóbal de Las Casas, Chiapas, so it is considered endangered by Mexican law (Contreras-Balderas et al. 2003; Velázquez-Velázquez and Schmitter-Soto 2004; Velázquez-Velázquez et al. 2008). The new record of this population expands its geographic range.

We expanded the known distributional range of *Paraneetroplus hartwegi* that has long been considered endemic to the upper Grijalva (Miller et al. 2005). González-Díaz et al. (2008) found that this species is common and abundant in the middle Grijalva in La Venta River basin and Malpaso Reservoir. Recently we found it in rivers and streams of the lower basin. Because of its abundance and distribution it may be necessary to reassess its conservation status, presently

considered as threatened by Mexican law. *Poecilia sphenops* has disjunct populations; it is distributed in rivers, streams and brackish lagoons of the Pacific coastal plain, but also in the Middle and Upper Grijalva and in the Coatzacoalcos River basin (Schultz and Miller 1971; Miller et al. 2005; González-Díaz et al. 2008); this species was collected in the upper parts of the Teapa-Tacotalpa and Tulijá-Macuspana systems, it occurs in sympatry with *Poecilia mexicana* but not in syntopy: whereas *P. mexicana* inhabits rivers and streams with fast flow, clear water and high concentration of dissolved oxygen, *P. sphenops* is found in ponds and lagoons without flow, high turbidity and low oxygen levels.

The species richness in the Grijalva River basin is lower in the upper parts and increases in the lower portions. The lower Grijalva is the most diverse region, due to the presence of peripheral species and components shared with the Usumacinta River. The upper basin has been severely affected by hydroelectrical power development; as a result, the distribution of some species has been altered, reduced, or eliminated. The isolation and the change of hydrological conditions caused the disappearance of migratory species such as *Agonostomus monticola*, mentioned by Taylor and Miller (1980), although actually there are no vouchered records. *Centropomus undecimalis* also penetrates to the middle section of the river, according to local fishermen. Presently, other species are very rare in the basin upper reaches, as is the case of *Ictiobus meridionalis*, *Eugerres mexicanus*, and *Aplodinotus grunniens*, but they are very common and abundant in the basin lower reaches, especially in the Tulijá-Macuspana system.

The secondary component is represented, with 54 species (65.1% of native species), mainly cichlids and poeciliids, the dominant families in most Central America river systems (Miller 1966, 1982; Myers 1966; Bussing 1998; Matamoros et al. 2015). Primary fishes are poorly represented, with only 11 species (13.3%), and marine derivatives with 18 species (21.7%), especially vicarious forms (species derived from marine ancestors, actually restricted to freshwater habitats). This paucity of primary freshwater fishes is also present in most basins of Central America, whereas in North and South America the fish fauna is dominated by ostariophysans, such as carps and minnows to the north and catfishes, characins, and knifefishes to the south (Miller 1966; Myers 1966; Bussing 1985; Smith and Bermingham 2005; Chakrabarty and Albert 2011; Matamoros et al. 2015).

Exotic species comprise an important source of food and are economically valuable in the upper basin, especially Nile Tilapia, *Oreochromis niloticus*, a fish widely distributed and found in almost all areas throughout the Grijalva basin. *Tilapia zillii*, another exotic cichlid, and *O. niloticus* are very common and abundant in the Upper Grijalva, mainly in La Angostura reservoir, in

which both sustain local fisheries and represent more than 50% of capture efforts. The abundance of exotic species seems to gradually decrease in the lower reaches of the basin, in which native species as *Petenia splendida*, *Ictalurus meridionalis*, *Atractosteus tropicus* and many native cichlids comprise the catch of local fisheries. Another problem related to exotic fishes in the upper section, especially with the Common Carp (*Cyprinus carpio*), is the presence of non-native parasites such as the Asian Tapeworm (*Bothriocephalus acheilognathi*), recently recorded in the endemic pupfishes *Profundulus candalarius* (pers. obs.) and *P. hildebrandi* (Velázquez-Velázquez et al. 2011). The Asian Parasitic Copepod (*Neoergasilus japonicus*) has been reported in the endemic cichlids *Cichlasoma grammodes*, *Paraneetroplus breidohri*, and *P. hartwegi* (Suárez-Morales et al. 2010); most of the parasitized species are included in a risk category according to Mexican law (NOM-059-SEMARNAT-2010), but it will be necessary to assess the presence of these exotic parasites in other native species. In the Lower Grijalva, the Armored Catfish (*Pterygoplichthys* spp.) represents a serious risk for the native fish fauna and the whole ecosystem, due to its high abundance and widespread distribution (Wakida-Kusunoki et al. 2007; Liénart et al. 2013). Additional effort is needed to attempt to control or eradicate the spread of this invasive species.

In conclusion, the present survey provides information for the monitoring of fish fauna and management of fishing resources in the Grijalva River basin, a highly diverse and economically important region in Middle America.

## ACKNOWLEDGEMENTS

We thank the Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO) and Comisión Federal de Electricidad (CFE) for financial support; also Comisión Nacional de Áreas Naturales Protegidas (CONANP) for authorization to work in protected areas and for logistic support, especially to the personnel of Selva El Ocote Biosphere Reserve, Cañón del Sumidero National Park and Cascadas de Agua Azul Forest Protection and Wildlife Area. We are very grateful to everyone who has contributed with fieldwork and processing of samples: Jesús Manuel López Vila, Julio César Ruiz Velasco, Carlos Gordillo Macías, Ever Vázquez Pérez, Anelli García López, José de Jesús Hernández Cruz, Diana Hermida Villarreal, Iván Arenas Balbuena, Víctor Villatoro Álvarez, Citlalli López Tapia, Marco Gómez López, Ismael Aguilar Pérez, Georgina Morales Flores, Karen García López, Oscar Sánchez Morales, Alejandro Jamangapé Ovando, Christian Narcia Rico, Ramón Ramos Aguilar, Eduardo Urbina Trejo, Limber Sigarroa Gómez and Gaspar Mayorga Chanona. Special thanks to Jorge Liévano Trujillo for map elaboration,

Karla Infante Ramírez for providing literature and Juan Jacobo Schmitter-Soto for the comments and suggestions in this manuscript.

## LITERATURE CITED

- Álvarez, J. 1970. Peces mexicanos (claves). Distrito Federal: Secretaría de Industria y Comercio. 166 pp.
- Bueno-Soria, J. and S. Santiago-Fragoso. 2002. Presa Nezahualcóyotl (Malpaso); pp. 567–587, in: G. De la Lanza-Espino y J. L. García Calderón (eds.). Lagos y presas de México. Distrito Federal: AGT editor. 680 pp.
- Bussing, W.A. 1985. Patterns of the distribution of the Central American ichthyofauna; pp. 453–473, in: F.G. Stehli and S.D. Webb (eds.). The Great American Biotic Interchange. New York: Plenum Press. doi: [10.1007/978-1-4684-9181-4\\_17](https://doi.org/10.1007/978-1-4684-9181-4_17)
- Bussing, W.A. 1998. Peces de las aguas continentales de Costa Rica. 2<sup>nd</sup> ed. San José: Universidad de Costa Rica. 468 pp.
- Castro-Aguirre, J.L., H.S. Espinoza-Pérez and J.J. Schmitter-Soto. 1999. Ictiofauna estuarino-lagunar y vicaria de México. Distrito Federal: Limusa/Instituto Politécnico Nacional. 711 pp.
- Contreras-Balderas, S., P. Almada-Villela, M.L. Lozano-Vilano and M.E. García-Ramírez. 2003. Freshwater fish at risk or extinct in México, a checklist and review. *Reviews in Fish Biology and Fisheries* 12: 241–251. doi: [10.1023/A:1025053001155](https://doi.org/10.1023/A:1025053001155)
- Chakrabarty, P. and J.S. Albert. 2011. Not so fast: a new take on the Great American Biotic Interchange; pp. 293–305, in: J.S. Albert and R.E. Reis (eds.), Historical biogeography of Neotropical freshwater fishes. Berkeley: University of California Press.
- Eschmeyer, W. N. (ed). 2015. Catalog of fishes. California Academy of Sciences. Accessed at <http://research.calacademy.org/ichthyology/catalog/fishcatsearch.html>, 23 February 2015.
- García-García, A. 2011. La cuenca hidrográfica transfronteriza Grijalva: la danza de politics-policy y el mapeo institucional en México y Guatemala. *Aqua-LAC* 3 (2): 127–140. [http://www.unesco.org/uy/ci/fileadmin/phi/aqualac/pp\\_127-140.pdf](http://www.unesco.org/uy/ci/fileadmin/phi/aqualac/pp_127-140.pdf)
- Gómez-González, A. E., E. Velázquez-Velázquez and M. Anzueto-Calvo. 2014. Primer registro de *Xiphophorus clemenciae* (Cyprinodontiformes: Poeciliidae) en la cuenca del río Grijalva, México. *Revista Mexicana de Biodiversidad* 85: 975–978. doi: [10.7550/rmb.35174](https://doi.org/10.7550/rmb.35174)
- González-Díaz, A. A., R. M. Quiñones, J. Velázquez-Martínez and R. Rodiles-Hernández. 2008. Fishes of La Venta River in Chiapas, México. *Zootaxa* 1685: 47–54. <http://www.mapress.com/zootaxa/2008/f/201685p054f.pdf>
- Hudson, P. H., D. A. Hendrickson, A. C. Benke, A. Varela-Romero, R. Rodiles-Hernández and W. L. Minckley. 2005. Rivers of Mexico; pp. 1031–1085, in: Benke A. C. and C. E. Cushing (eds.), *Rivers of North America*. Burlington, Massachusetts: Elsevier.
- Liénart, G. H, R. Rodiles-Hernández and K. Capps. 2013. Nesting burrows and behavior of nonnative catfishes (Siluriformes: Loricariidae) in the Usumacinta-Grijalva watershed, Mexico. *The Southwestern Naturalist* 58 (2): 238–243. doi: [10.1894/0038-4909-58.2.238](https://doi.org/10.1894/0038-4909-58.2.238)
- Lozano, V. M. and Contreras, B. S. 1987. Lista zoogeográfica y ecológica de la Ictiofauna continental de Chiapas, México. *The Southwestern Naturalist* 32(2): 223–236. <http://www.jstor.org/stable/3671565>
- Matamoros, W. A., C. D. McMahan, P. Chakrabarty, J. S. Albert and J. F. Schaefer. 2015. Derivation of the freshwater fish fauna of Central America revisited: Myers's hypothesis in the twenty-first century. *Cladistics* 31(1): 177–188. doi: [10.1111/cla.12081](https://doi.org/10.1111/cla.12081)
- Miller, R. R. 1966. Geographical distribution of Central American freshwater fishes. *Copeia* 1966: 773–802. <http://www.jstor.org/stable/1441406>
- Miller, R.R. 1982. Pisces; pp. 486–501, in: S.H. Hulbert and A.



- Villalobos-Figueroa (eds.). Aquatic biota of Mexico, Central America and the West Indies. San Diego: San Diego State University.
- Miller, R.R., W.L. Minckley and S.M. Norris. 2005. Freshwater fishes of México. Chicago: The University of Chicago Press. 490 pp.
- Myers, G. S. 1938. Freshwater fishes and West Indian zoogeography. Annual Report of the Board of Regents of the Smithsonian Institution 1937: 339–364.
- Myers, G.S. 1966. Derivation of the freshwater fish fauna of Central America. *Copeia* 1966: 766–773. <http://www.jstor.org/stable/1441405>
- Nelson, J.S. 2006. Fishes of the World. 4<sup>th</sup> ed. Hoboken: John Wiley and Sons. 601 pp.
- Olmos-Tomasini, E. 2002. Presa La Angostura (Belisario Domínguez), México; pp. 590–599, in: G. De la Lanza-Espino and J.L. García-Calderón (eds.). Lagos y presas de México. Mexico City: AGT editor. 680 pp.
- Pérez, P.A., E. Cabrera, E.A. Bermúdez and R.M. Gutiérrez. 2002. Presa Dr. Belisario Domínguez (La Angostura), Chiapas; pp. 130–165, in: P.A. Pérez, L.E. Cruz, E.A. Bermúdez, E. Cabrera and R.M. Gutiérrez (eds.). Pesquerías en tres cuerpos de aguas continentales de México. Mexico City: Instituto Nacional de la Pesca/Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación. 125 pp.
- Rodiles-Hernández, R. 2005. Diversidad de peces continentales en Chiapas; pp. 195–220, In: M. González-Espinosa, N. Ramírez-Marcial y L. Ruiz-Montoya (eds.). Diversidad biológica de Chiapas. Distrito Federal: Plaza y Valdés/ECOSUR/COCYTECH, Mexico City.
- Schultz, R. J. and R. R. Miller. 1971. Species of the *Poecilia sphenops* complex (Pisces: Poeciliidae) in Mexico. *Copeia* 1971: 282–290. <http://www.jstor.org/stable/1442828>
- SEMARNAT (Secretaría de Medio Ambiente y Recursos Naturales). 2010a. ACUERDO por el que se dan a conocer los estudios técnicos de aguas nacionales superficiales de las subregiones hidrológicas Alto Grijalva, Medio Grijalva y Bajo Grijalva de la Región Hidrológica No. 30 Grijalva-Usumacinta. Diario Oficial de la Federación. 29 de abril de 2010. [http://dof.gob.mx/nota\\_detalle.php?codigo=5141106&fecha=29/04/2010](http://dof.gob.mx/nota_detalle.php?codigo=5141106&fecha=29/04/2010)
- SEMARNAT (Secretaría de Medio Ambiente y Recursos Naturales). 2010b. Norma Oficial Mexicana NOM-059-SEMARNAT-2010, Protección Ambiental – Especies nativas de México de flora y fauna silvestres – Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio – lista de especies en riesgo. Diario Oficial de la Federación. 30 de diciembre de 2010, Segunda Sección. <http://biblioteca.semarnat.gob.mx/janium/Documentos/Ciga/agenda/DOFs/DO2454.pdf>
- Smith, S.A. and E. Bermingham. 2005. The biogeography of lower Mesoamerican freshwater fishes. *Journal of Biogeography* 32: 1835–1854. doi: [10.1111/j.1365-2699.2005.01317.x](https://doi.org/10.1111/j.1365-2699.2005.01317.x)
- Suárez-Morales, E., A. Paredes-Trujillo and D. González-Solís. 2010. The introduced Asian parasitic copepod *Neoergasilus japonicus* (Harada) (Cyclopoida: Ergasilidae) from endangered cichlid teleosts in Mexico. *Zoological Science* 27: 851–855. doi: [10.2108/zsj.27.851](https://doi.org/10.2108/zsj.27.851)
- Tamayo, J.L. and R.C. West. 1964. The hydrology of Middle America; pp. 84–121, in: R. Wauchope and R.C. West (eds.). Handbook of Middle American Indians I. Austin: University of Texas.
- Taylor and R. R. Miller. 1980. Two new cichlid fishes, genus *Cichlasoma*, of Chiapas, Mexico. Occasional Papers of the Museum of Zoology, University of Michigan 693: 1–16. <http://deepblue.lib.umich.edu/bitstream/handle/2027.42/57129/OP693.pdf>
- Toledo, A. 2003. Ríos, costas, mares. Hacia un análisis integrado de las regiones hidrológicas de México. Distrito Federal: Instituto Nacional de Ecología/Secretaría de Medio Ambiente y Recursos Naturales/El Colegio de Michoacán. 117 pp.
- Velázquez-Velázquez, E., D. González-Solís and G. Salgado-Maldonado. 2011. *Bothriocephalus acheilognathi* (Cestoda) in the endangered fish *Profundulus hildebrandi* (Cyprinodontiformes), Mexico. *Revista de Biología Tropical* 59(3): 1099–104. <http://www.redalyc.org/articulo.oa?id=44922150012>
- Velázquez-Velázquez, E. and J. J. Schmitter-Soto. 2004. Conservation status of *Profundulus hildebrandi* Miller (Teleostei: Profundulidae) in the face of urban growth in Chiapas, México. *Aquatic Conservation: Marine and Freshwater Ecosystems* 14: 201–209. doi: [10.1002/aqc.605](https://doi.org/10.1002/aqc.605)
- Velázquez-Velázquez, E., J. J. Schmitter-Soto and S. Domínguez-Cisneros. 2008. Threatened fishes of the world: *Profundulus hildebrandi* Miller, 1950 (Profundulidae). *Environmental Biology of Fishes* 84(4): 345–346. doi: [10.1007/s10641-008-9425-8](https://doi.org/10.1007/s10641-008-9425-8)
- Velázquez-Velázquez, E., S. Contreras-Balderas, S. E. Domínguez-Cisneros and A. E. Gómez-González. 2013. Riqueza y diversidad de peces continentales; pp. 275–282, in: La biodiversidad en Chiapas: Estudio de Estado. Distrito Federal: Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO)/Gobierno del Estado de Chiapas.
- Wakida-Kusunoki, A., R. Ruiz-Carus and E. Amador-Del-Angel. 2007. The Amazon sailfin catfish *Pterygoplichthys pardalis* (Castelnaud, 1855) (Loricariidae), another exotic species established in southeastern Mexico. *The Southwestern Naturalist* 52 (1): 141–143. doi: [10.1894/0038-4909\(2007\)52\[141:ASCPPC\]2.o.CO;2](https://doi.org/10.1894/0038-4909(2007)52[141:ASCPPC]2.o.CO;2)

**Authors' contribution statement:** AEGG wrote the manuscript, collected and identified the species, EVV identified the species, MJAC and MFMC collected and identified species. All authors reviewed and approved the manuscript.

**Received:** 2 April 2015

**Accepted:** 23 July 2015

**Academic editor:** Tiago Carvalho

## Appendix 1

Catalog numbers of the species deposited at the Museo de Zoología, UNICACH (MZ-UNICACH):

***Atractosteus tropicus*:** 4655. ***Megalops atlanticus*:** 4660. ***Dorosoma anale*:** 1295, 1297, 1368, 1372, 1405, 1407, 1412, 1455, 1506, 1528, 1627, 1676, 1678, 1682, 1706, 1775, 1782, 1788, 1809, 1868, 1876, 1883, 1887, 1896, 1901, 1914, 1955, 1961, 1966, 2000, 2037, 2041, 2045, 2052, 2056, 2059, 2074, 2078, 2168, 2173, 2183, 2189, 2191, 2202, 2228, 2239, 2242, 2358, 2364, 2366, 2367, 2369, 2371, 2372, 2373, 2386, 2388, 2389, 2391, 2395, 2398, 2399, 2429, 2537, 2554, 2559, 2561, 2591, 2601, 2608, 2612, 2614, 2641, 2643, 2663, 2664, 2665, 2667, 2670, 2682, 2693, 2697, 2700, 2777, 2794, 2832, 2834, 2839, 2843, 2883, 2910, 2912, 2921, 2925, 2930, 2979, 2987, 2991, 2992, 2995, 3042, 3101, 3149, 3271, 3276, 3287, 3288, 3294, 3304, 3509, 3525, 3534, 3583, 3620, 3719, 3735, 3746, 3753, 3766, 3795, 3798, 3979, 4012, 4053, 4085, 4093, 4143, 4260, 4566, 4573, 4639, 4956, 5008, 5051, 5144, 5181. ***Dorosoma petenense*:** 1260, 1275, 1279, 1283, 1299, 1370, 1374, 1413, 1417, 1474, 1499, 1505, 1511, 1523, 1532, 1650, 1697, 1698, 1713, 1722, 1725, 1742, 1765, 1792, 1836, 1856, 1869, 1875, 1894, 1902, 1973, 1990, 2005, 2012, 2015, 2030, 2050, 2065, 2080, 2085, 2167, 2194, 2211, 2216, 2222, 2252, 2351, 2354, 2361, 2362, 2365, 2368, 2385, 2403, 2404, 2414, 2421, 2422, 2526, 2535, 2542, 2543, 2566, 2572, 2581, 2585, 2611, 2617, 2652, 2669, 2685, 2767, 2790, 2824, 2849, 2855, 2865, 2874, 2885, 2902, 2937, 2941, 2942, 2957, 2961, 2966, 2967, 2973, 2975, 3084, 3113, 3283, 3482, 3489, 3499, 3510, 3513, 3522, 3523, 3532, 3535, 3550, 3557, 3576, 3581, 3591, 3604, 3624, 3703, 3712, 3740, 3745, 3752, 3760, 3778, 3822, 3827, 3836, 3844, 3850, 3859, 3863, 3866, 3884, 3889, 3893, 3928, 3934, 3951, 3959, 3962, 3970, 3985, 3998, 4003, 4015, 4049, 4060, 4075, 4098, 4120, 4140, 4145, 4168, 4175, 4214, 4574, 4636, 4646, 4904, 4955, 4967, 4996, 5009, 5030, 5032, 5044, 5046, 5049, 5052, 5055, 5137, 6201. ***Cyprinus carpio*:**



1234, 1236, 1237, 4305, 4306, 4311, 4321, 4363, 4375, 4380, 5020, 5022, 5023, 5110, 5166. **Ctenopharyngodon idella**: 4659. **Astyanax aeneus**: 3, 17, 36, 38, 39, 40, 50, 78, 91, 96, 103, 1014, 1021, 1022, 1024, 1026, 1028, 1029, 1033, 1034, 1039, 1045, 1048, 1051, 1057, 1058, 1060, 1061, 1062, 1063, 1069, 1077, 1078, 1079, 1084, 1085, 1088, 1089, 1090, 1091, 1095, 1096, 1097, 1102, 1103, 1104, 1105, 1110, 1111, 1113, 1115, 1117, 1118, 1120, 1123, 1126, 1127, 1130, 1133, 1152, 1153, 1160, 1163, 1165, 1167, 1177, 1182, 1184, 1206, 1208, 1210, 1216, 1219, 1222, 1223, 1244, 1257, 1261, 1262, 1263, 1266, 1272, 1276, 1280, 1282, 1289, 1293, 1294, 1296, 1304, 1309, 1314, 1344, 1347, 1363, 1365, 1376, 1393, 1396, 1397, 1400, 1411, 1419, 1425, 1441, 1446, 1449, 1451, 1469, 1484, 1503, 1516, 1518, 1529, 1544, 1547, 1550, 1558, 1575, 1577, 1582, 1601, 1608, 1610, 1613, 1618, 1623, 1636, 1645, 1656, 1667, 1668, 1687, 1703, 1728, 1734, 1743, 1755, 1763, 1766, 1799, 1817, 1822, 1832, 1855, 1866, 1880, 1895, 1903, 1908, 1912, 1934, 1946, 1950, 1967, 1977, 1989, 1995, 2014, 2033, 2049, 2060, 2066, 2079, 2081, 2086, 2087, 2097, 2099, 2104, 2107, 2108, 2113, 2119, 2126, 2129, 2131, 2135, 2142, 2145, 2164, 2177, 2207, 2213, 2223, 2227, 2234, 2237, 2245, 2251, 2255, 2260, 2275, 2278, 2282, 2284, 2285, 2288, 2294, 2297, 2305, 2310, 2316, 2319, 2326, 2343, 2346, 2347, 2360, 2381, 2405, 2406, 2407, 2420, 2423, 2426, 2430, 2509, 2532, 2546, 2551, 2556, 2575, 2577, 2595, 2598, 2604, 2616, 2618, 2628, 2629, 2649, 2651, 2656, 2686, 2702, 2708, 2717, 2726, 2735, 2738, 2747, 2750, 2751, 2760, 2787, 2793, 2798, 2806, 2811, 2826, 2907, 2915, 2952, 2956, 2977, 3067, 3071, 3104, 3131, 3138, 3152, 3156, 3159, 3161, 3164, 3168, 3170, 3176, 3184, 3187, 3190, 3196, 3216, 3225, 3235, 3239, 3245, 3258, 3264, 3275, 3285, 3286, 3289, 3292, 3464, 3474, 3511, 3515, 3531, 3562, 3575, 3579, 3585, 3593, 3598, 3621, 3630, 3633, 3635, 3638, 3640, 3642, 3645, 3648, 3655, 3662, 3666, 3669, 3676, 3678, 3682, 3687, 3691, 3710, 3738, 3742, 3754, 3761, 3773, 3781, 3801, 3806, 3824, 3837, 3840, 3846, 3860, 3869, 3896, 3944, 3958, 3961, 3982, 3989, 3994, 4000, 4033, 4039, 4042, 4050, 4061, 4102, 4105, 4119, 4124, 4130, 4137, 4144, 4156, 4160, 4200, 4221, 4223, 4225, 4255, 4337, 4338, 4362, 4369, 4372, 4373, 4390, 4392, 4393, 4399, 4411, 4412, 4416, 4420, 4422, 4423, 4424, 4429, 4431, 4433, 4437, 4438, 4443, 4449, 4454, 4455, 4456, 4466, 4525, 4530, 4533, 4564, 4567, 4577, 4638, 4647, 4686, 4696, 4704, 4779, 4797, 4805, 4810, 4957, 5012, 5016, 5041, 5042, 5045, 5047, 5050, 5053, 5066, 5068, 5077, 5080, 5094, 5097, 5106, 5109, 5114, 5120, 5127, 5133, 5136, 5158, 5165, 5178, 5296, 5300, 5311, 6203, 6218. **Bramocharax sp.**: 4895, 4895, 4743, 4888, 4859. **Brycon guatemalensis**: 114, 1037, 1038, 1040, 1044, 1067, 1254, 1287, 1300, 1319, 1342, 1349, 1356, 1367, 1375, 1383, 1406, 1410, 1445, 1454, 1457, 1463, 1466, 1565, 1590, 1598, 1629, 1680, 1736, 1798, 1811, 1815, 1841, 1892, 1897, 1911, 1945, 1974, 2007, 2025, 2036, 2042, 2046, 2055, 2058, 2071, 2077, 2100, 2111, 2117, 2122, 2169, 2174, 2188, 2238, 2247, 2296, 2336, 2339, 2379, 2380, 2427, 2558, 2583, 2610, 2613, 2657, 2662, 2678, 2681, 2687, 2688, 2690, 2696, 2714, 2724, 2728, 2733, 2745, 2780, 2837, 2845, 2884, 2919, 2954, 2972, 2993, 2998, 3010, 3015, 3039, 3057, 3063, 3073, 3123, 3133, 3136, 3137, 3148, 3171, 3174, 3191, 3218, 3222, 3231, 3234, 3257, 3259, 3263, 3265, 3274, 3277, 3282, 3291, 3331, 3439, 3441, 3445, 3447, 3450, 3456, 3458, 3480, 3490, 3528, 3608, 3637, 3652, 3673, 3686, 3796, 3930, 3984, 4006, 4010, 4055, 4067, 4087, 4110, 4147, 4158, 4183, 4190, 4257, 4386, 4409, 4413, 4418, 4445, 4462, 4569, 4670, 4675, 4681, 4695, 4699, 4705, 4905, 4916, 5002, 5005, 5011, 5015, 5033, 5048, 5096, 5155, 5279, 5289, 5291, 5295. **Ictalurus meridionalis**: 1359, 1404, 1430, 1436, 1453, 1500, 1675, 1700, 1717, 1740, 1773, 1776, 1812, 1813, 1852, 1873, 1885, 1889, 1944, 1962, 1972, 2002, 2026, 2034, 2038, 2047, 2057, 2076, 2093, 2102, 2115, 2123, 2193, 2212, 2536, 2563, 2698, 2704, 2705, 2713, 2768, 2774, 2846, 2852, 2859, 2917, 2997, 2999, 3198, 3281, 3303, 3468, 3507, 3588, 3616, 3685, 3715, 3741, 3748, 3826, 3845, 3851, 3879, 3929, 4017, 4041, 4076, 4084, 4089, 4094, 4103, 4118, 4261, 5301. **Cathorops kailolae**: 1286, 1340, 1369, 1373, 1414, 1508, 1510, 1630, 1642, 1669, 1673, 1685, 1686, 1709, 1727, 1741, 1786, 1796, 1805, 1884, 1952, 1963, 1968, 2021, 2172, 2198, 2204, 2206, 2229, 2515, 2555, 2562, 2567, 2695, 2769, 2781, 2797, 2820, 2842, 2857, 2903, 2914, 2924, 2932, 2994, 3469, 3497, 3506, 3519, 3526, 3530, 3590, 3625, 3714, 3721, 3736, 3744, 3800, 3834, 3847, 3861, 3926, 3941, 3949, 3955, 3983, 3997, 4014, 4046, 4052, 4062, 4088, 4100, 4134, 5031, 5292, 5310. **Potamarius nelsoni**: 1380, 1487, 1509, 1626, 1691, 1784, 1790, 1882, 1958, 2035, 2040, 2075, 2187, 2231, 2243, 2539, 2600, 2779, 2833, 2840, 2989, 3000, 3146, 3799, 3945, 3980, 4054, 4091, 4658. **Rhamdia laluchensis**: 1702, 2809, 2810. **Rhamdia laticauda**: 1339, 1679, 1683, 1770, 1814, 1957, 1965, 2004, 2020, 2044, 2195, 2236, 2568, 2599, 2753, 2775, 2800, 2931, 3019, 3043, 3442, 4090, 4131, 4193, 4434, 4435, 4460, 5271, 5272, 6652. **Rhamdia guatemalensis**: 1, 5, 1143, 1255, 1268, 1312, 1317, 1325, 1361, 1398, 1428, 1435, 1442, 1526, 1561, 1571, 1579, 1587, 1640, 1647, 1654, 1666, 1672, 1677, 1684, 1750, 1781, 1842, 1863, 1879, 1909, 1926, 1970, 1985, 1996, 2032, 2134, 2218, 2261, 2281, 2312, 2318, 2331, 2548, 2582, 2709, 2754, 2755, 2801, 2822, 3064, 3169, 3233, 3296, 3514, 3611, 3643, 3660, 3671, 3726, 3750, 3791, 3804, 3814, 3832, 3871, 3947, 3988, 4013, 4096, 4126, 4195, 4439, 4471, 4517, 4537, 4731, 4747, 4781, 4824, 5083. **Rhamdia macuspanensis**: 6651. **Pterygoplichthys spp.**: 116, 117, 1194, 1203, 4325, 6208. **Batrachoides goldmani**: 2508, 4293. **Atherinella alvarezii**: 1073, 1108, 1278, 1424, 1439, 1496, 1513, 1537, 1540, 1541, 1643, 1658, 1712, 1715, 1759, 1771, 1802, 1835, 1844, 1846, 1910, 1915, 1918, 1980, 1993, 2009, 2011, 2160, 2176, 2249, 2314, 2350, 2352, 2363, 2382, 2393, 2401, 2410, 2412, 2510, 2523, 2557, 2609, 2622, 2624, 2632, 2639, 2655, 2772, 2782, 2815, 2860, 2869, 2879, 2933, 2959, 2962, 2985, 3003, 3048, 3053, 3078, 3262, 3267, 3461, 3476, 3488, 3493, 3563, 3610, 3613, 3727, 3733, 3757, 3765, 3785, 3805, 3811, 3872, 3880, 3886, 3931, 3938, 3967, 3976, 3992, 4024, 4044, 4059, 4113, 4173, 4201, 4215, 4258, 4353, 4357, 4575, 4829, 4914, 5014, 5139, 5182, 5299, 5308, 6204. **Strongylura hubbsii**: 1486, 2154, 2511, 2530, 2955, 3345, 3578, 4724, 5017, 6200. **Hyporhamphus mexicanus**: 1250, 1371, 1512, 1655, 1701, 1714, 1953, 1983, 2027, 2163, 2527, 2863, 2864, 2958, 2960, 3481, 3487, 3529, 3536, 3559, 3704, 3716, 3891, 3991. **Cynodonichthys tenuis**: 4294. **Profundulus candalarius**: 14, 66, 70, 3897, 3898, 3899, 3900, 3903, 3905, 3906. **Profundulus hildebrandi**: 5694, 6194. **Profundulus labialis**: 32, 102, 1017, 1027, 1035, 1043, 1050, 1052, 1059, 1064, 1068, 1094, 1098, 1107, 1121, 1124, 1129, 1157, 1162, 1178, 1233, 1240, 1243, 1273, 1305, 1315, 1322, 1354, 1360, 1395, 1402, 1450, 1458, 1465, 1468, 1552, 1567, 1581, 1605, 1615, 1617, 1638, 1752, 1824, 1921, 1929, 1933, 1940, 1994, 2092, 2106, 2121, 2127, 2139, 2283, 2300, 2304, 2313, 2325, 2338, 2344, 2574, 2621, 2637, 2715, 2723, 2734, 2736, 2756, 3014, 3020, 3052, 3060, 3069, 3083, 3085, 3117, 3121, 3132, 3135, 3139, 3142, 3155, 3173, 3179, 3200, 3205, 3214, 3215, 3221, 3226, 3237, 3240, 3246, 3427, 3436, 3443, 3446, 3448, 3451, 3467, 3473, 3661, 3664, 3689, 3693, 3700, 3875, 4035, 4036, 4040, 4107, 4109, 4149, 4155, 4186, 4196, 4199, 4310, 4333, 4336, 4339, 4347, 4359, 4368, 4370, 4374, 4473, 4474, 4479, 4482, 4485, 4496, 4499, 4501, 4503, 4504, 4513, 4518, 4524, 4529, 4538, 4561, 4679, 4694, 4703, 4706, 4818, 4912, 5006, 5019, 5026, 5029, 5064, 5069, 5071, 5079, 5081, 5087, 5090, 5095, 5105, 5108, 5126, 5152, 5186, 5270, 5274, 5297, 6220. **Profundulus punctatus**: 6, 79, 92, 118, 1321, 1399, 1427, 1482, 1569, 1586, 1801, 1821, 1823, 2262, 2266, 2417, 2552, 2623, 2636, 3100, 3183, 3542, 3657, 4163, 4211, 4332, 4361, 4371, 4450, 4472, 4480, 4481, 4484, 4487, 4494, 4498, 4505, 4520, 4528, 4534, 4640, 4702, 5063, 5067, 5074, 5076, 5085, 5101, 5113, 5116, 5125, 5143, 5147, 5150, 5154, 5160, 5175, 5278. **Belonesox belizanus**: 6196. **Carllhubbsia kidderi**: 4323, 6195. **Gambusia eurystoma**: 6212. **Gambusia sexradiata**: 4324, 5102, 5129, 5173, 5305, 6206. **Gambusia yucatanana**: 1720, 1838, 4352. **Heterophallus echeagarayi**: 4345. **Poeciliopsis fasciata**: 51, 1211, 1220, 1226, 1245, 1249, 1274, 1324, 1343, 1362, 1387, 1418, 1426, 1460, 1471, 1478, 1483, 1494, 1543, 1548, 1555, 1562, 1566, 1585, 1588, 1604, 1612, 1641, 1652, 1719, 1758, 1767, 1818, 1830, 1840, 1847, 3009, 3013, 3034, 3035, 3037, 3046, 3047, 3049, 3050, 3066, 3068, 3074, 3077, 3090, 3106, 3115, 3134, 3229, 3243, 3253, 3256, 3260, 3266, 3438, 3452, 3454, 3460, 3477, 3478, 3483, 3494, 3792, 3823, 4148, 4154, 4162, 4166, 4177, 4179, 4180, 4192, 4220, 4222, 4224, 4234, 4256, 4360, 4415, 4444, 4457, 4458, 4465, 4483, 4489, 4493, 4500, 4509, 4512, 4515, 4523, 4527, 4908, 4911, 4917, 5004, 5007, 5010, 5072, 5091, 5103, 5111, 5115, 5117, 5124, 5135, 5153, 5163, 5183, 5275, 5284, 5287, 5294, 5298, 5309. **Poeciliopsis hnlickai**: 62, 1016, 1020,

1031, 1042, 1047, 1055, 1056, 1072, 1074, 1082, 1086, 1109, 1119, 1136, 1139, 1146, 1149, 1161, 1168, 1170, 1173, 1175, 1179, 1181, 1187, 1217, 1218, 1224, 1225, 1227, 1228, 1229, 1480, 1593, 1733, 1820, 2267, 2271, 2274, 2279, 3012, 3059, 3061, 3072, 3140, 3150, 3227, 3241, 3248, 3457, 3462, 3465, 3484, 3491, 4106, 4191, 4197, 4202, 4389, 4425, 4526, 4546, 4906, 4910, 5003, 5065, 5070, 5073, 5075, 5082, 5084, 5088, 5092, 5098, 5118, 5142, 5149, 5151, 5157, 5159, 5174, 5176. **Poeciliopsis pleurospilus**: 97, 99, 1205, 1212, 1214, 1221, 1230, 1235, 1238, 1241, 1256, 1267, 1271, 1307, 1310, 1313, 1326, 1346, 1352, 1358, 1401, 1422, 1443, 1447, 1473, 1475, 1476, 1479, 1570, 1576, 1583, 1591, 1609, 2720, 2722, 2737, 2748, 3016, 3058, 3062, 3070, 3076, 3079, 3082, 3091, 3105, 3120, 3153, 3232, 3238, 3247, 3437, 3453, 3466, 3475, 3485, 3654, 3663, 3674, 3677, 3681, 3688, 4108, 4157, 4194, 4198, 4259, 4302, 4304, 4307, 4312, 4313, 4315, 4317, 4320, 4334, 4335, 4350, 4367, 4376, 4378, 4384, 4400, 4401, 4404, 4414, 4419, 4421, 4469, 4486, 4488, 4495, 4502, 4508, 4511, 4516, 4521, 4536, 5021, 5024, 5027, 5104, 5112, 5122, 5138, 5141, 5179, 5180, 5185, 5277, 5280, 5288, 5293, 5303, 5307. **Poecilia mexicana**: 1015, 1018, 1023, 1025, 1032, 1036, 1041, 1046, 1049, 1054, 1066, 1070, 1071, 1076, 1083, 1093, 1099, 1100, 1106, 1112, 1114, 1122, 1131, 1134, 1137, 1141, 1144, 1147, 1154, 1158, 1164, 1166, 1174, 1176, 1183, 1185, 1247, 1328, 1337, 1389, 1421, 1514, 1542, 1549, 1551, 1633, 1634, 1657, 1704, 1705, 1732, 1751, 1754, 1808, 1843, 1854, 1870, 1922, 1923, 1928, 1931, 1938, 1943, 1987, 1999, 2112, 2128, 2130, 2133, 2150, 2162, 2225, 2232, 2233, 2250, 2257, 2290, 2292, 2298, 2301, 2303, 2307, 2308, 2322, 2519, 2533, 2569, 2586, 2743, 2746, 2759, 2763, 2765, 2802, 2807, 2808, 2812, 2818, 2830, 2876, 2889, 2893, 2898, 2906, 2935, 3055, 3075, 3081, 3089, 3158, 3160, 3162, 3166, 3167, 3182, 3254, 3255, 3261, 3459, 3463, 3486, 3631, 3639, 3644, 3647, 3650, 3668, 3684, 3705, 3718, 3729, 3762, 3782, 3808, 3812, 3815, 3849, 3856, 3870, 3892, 3924, 3936, 3987, 3996, 4045, 4058, 4073, 4112, 4117, 4128, 4133, 4135, 4171, 4178, 4736, 4776, 4872, 4844, 4834, 4836, 4885, 4887, 4733, 4751, 4760, 4771, 4774, 4827, 4846, 4857, 4864, 4876, 4881, 4889, 4891, 4766, 4841, 4849, 4851, 6215, 6219. **Poecilia sphenops**: 7, 26, 29, 49, 90, 95, 100, 1209, 1213, 1215, 1231, 1246, 1265, 1269, 1308, 1320, 1353, 1364, 1403, 1416, 1462, 1464, 1470, 1477, 1481, 1495, 1554, 1573, 1578, 1589, 1595, 1599, 1602, 1607, 1614, 1825, 1919, 1937, 1997, 2061, 2067, 2095, 2114, 2120, 2138, 2181, 2224, 2265, 2269, 2280, 2317, 2328, 2332, 2337, 2707, 2710, 2719, 3192, 3197, 3502, 3658, 3692, 3701, 4391, 4408, 4426, 4441, 4490, 4491, 4492, 4507, 4510, 4514, 4522, 4535, 4562, 4669, 4678, 4687, 4698, 4701, 4782, 4807, 4813, 4817, 4823, 4831, 4898, 5078, 5086, 5089, 5119, 5123, 5128, 5134, 5164, 5177, 5184, 5276, 5283, 5286. **Poecilia sulphuraria**: 6211. **Priapella compressa**: 4730, 4754, 4762, 4772, 4865, 4890, 4894, 4765, 4778. **Priapella intermedia**: 1332, 1334, 1390, 1831, 2146, 2244, 2592, 2597, 2762, 2803, 3605, 3627, 3636. **Priapella chamulae**: 6214. **Pseudoxiphophorus bimaculatus**: 30, 58, 1159, 1172, 1258, 1277, 1311, 1316, 1391, 1394, 1440, 1546, 1603, 1621, 1622, 1624, 1731, 1753, 1936, 1948, 2082, 2083, 2103, 2105, 2132, 2140, 2143, 2148, 2178, 2199, 2254, 2258, 2259, 2287, 2289, 2291, 2293, 2299, 2302, 2306, 2309, 2545, 2587, 2588, 2683, 2721, 2727, 2731, 2732, 2739, 2740, 2742, 2744, 2749, 2804, 2816, 2829, 2831, 2888, 2920, 2946, 2950, 2963, 3154, 3163, 3181, 3186, 3188, 3189, 3551, 3552, 3634, 3656, 3659, 3665, 3667, 3670, 3695, 3696, 3697, 3787, 4009, 4729, 4752, 4759, 4767, 4777, 4840, 4850, 4854, 4866, 4892. **Xiphophorus clemenciae**: 1259, 1302, 1392, 1935, 2141, 2144, 2235, 2246, 2295, 2594, 2596, 2764, 3185, 3629, 3641, 4189, 1075, 1081, 1116, 1135, 1138, 1148, 1150, 1169, 1180, 1186, 2253. **Xiphophorus hellerii**: 1338, 1350, 1388, 1432, 1557, 1632, 1795, 2964, 4737, 4734, 4755, 4761, 4768, 4847, 4855, 4863, 4883, 4764, 4873, 6216. **Xiphophorus maculatus**: 6205. **Ophisternon aenigmaticum**: 80, 1145, 1188, 1303, 1420, 2276, 2341, 3157, 3165, 3653, 3679, 4918, 5148. **Centropomus undecimalis**: 4653. **Eugerres mexicanus**: 5162, 1379, 1456, 1899, 2043, 2627, 4057, 4663. **Aplodinotus grunniens**: 1378, 1507, 1723, 1886, 2089, 2241, 2540, 4056, 2699, 2916, 2928, 2929, 2017, 2564. **Amphilophus macracanthus**: 1423, 1438, 1459, 1568, 1580, 1584, 1600, 1606, 1653, 1893, 1920, 2315, 2324, 2703, 2712, 2970, 2980, 3195, 3694, 3952, 3968, 4007. **Cichlasoma grammodes**: 20, 23, 44, 87, 89, 93, 101, 3018, 3217, 3223, 3230, 3440, 4151, 4153, 4402, 4403, 4406, 4447, 4453, 4467, 4497, 4642, 4784, 4822, 4909, 5093, 5099, 5107, 5121, 5156, 5161, 5273, 5302. **Cichlasoma salvini**: 1290, 1291, 1327, 1331, 1333, 1377, 1497, 1559, 1671, 1747, 1803, 1829, 1857, 1872, 1927, 1939, 2152, 2221, 2323, 2531, 2900, 3004, 3051, 3178, 3299, 3555, 3592, 3599, 3609, 3617, 3623, 3628, 3707, 3711, 3763, 3775, 3829, 3841, 3857, 3950, 3957, 3971, 4004, 4023, 4066, 4070, 4077, 4129, 4718, 4721, 6209, 6213. **Cichlasoma trimaculatum**: 98, 1323, 1429, 1563, 1620, 1631, 2098, 2345, 3199, 4666, 4691, 4780, 4814, 5130. **Cichlasoma urophthalmus**: 112, 1288, 4355, 4665, 4832, 5056, 5146. **Oreochromis mossambicus**: 1292, 1553, 2124. **Oreochromis niloticus**: 135, 1437, 1492, 1519, 1564, 1696, 1907, 1979, 2048, 2064, 2091, 2158, 2165, 2186, 2205, 2226, 2355, 2356, 2390, 2402, 2411, 2418, 2419, 2425, 2512, 2514, 2522, 2606, 2626, 2646, 2648, 2650, 2660, 2674, 2691, 2784, 2791, 2821, 2878, 2895, 2971, 2982, 3036, 3054, 3080, 3103, 3118, 3252, 3269, 3279, 3298, 3472, 3545, 3596, 3731, 3770, 3788, 3820, 3833, 3881, 3933, 4043, 4072, 4185, 4216, 4218, 4226, 4229, 4396, 4397, 4398, 4407, 4427, 4448, 4468, 4519, 4563, 4637, 4674, 4680, 4684, 4821, 4915, 5100, 5132, 5145, 5282, 5290. **Parachromis managuensis**: 1493, 1531, 1646, 1648, 1649, 1699, 1721, 1724, 1749, 1779, 1806, 1862, 1900, 1954, 1959, 1978, 2019, 2157, 2161, 2197, 2528, 2576, 2579, 2680, 2776, 2788, 2813, 2817, 2827, 2838, 2875, 2882, 2886, 2890, 2891, 2892, 2894, 2899, 2905, 2922, 2939, 2978, 3088, 3116, 3143, 3244, 3297, 3305, 3512, 3516, 3524, 3540, 3544, 3561, 3568, 3570, 3580, 3587, 3594, 3603, 3607, 3622, 3725, 3728, 3755, 3776, 3783, 3810, 3813, 3842, 3854, 3888, 3894, 3925, 3943, 3946, 4016, 4022, 4071, 4078, 4082, 4125, 4139, 4219, 4506, 4555, 4657, 4689, 4690, 4710, 4835, 5131, 5140, 5285, 5304, 5306. **Paraneetroplus argenteus**: 4664. **Paraneetroplus bifasciatus**: 6292, 6654, 6656. **Paraneetroplus breidohri**: 45. **Paraneetroplus fenestratus**: 4723. **Paraneetroplus gibbiceps**: 6210, 6293, 6650, 6653. **Paraneetroplus hartwegi**: 41, 1207, 1239, 1242, 1431, 1853, 2008, 2110, 2387, 2394, 2633, 2640, 2658, 2661, 2672, 2684, 2689, 3038, 3040, 3041, 3044, 3045, 3065, 3087, 3114, 3141, 3145, 3151, 3172, 3175, 3180, 3219, 3224, 3236, 3273, 3278, 3280, 3302, 3444, 3449, 3470, 3500, 3504, 3518, 3539, 3547, 3556, 3571, 3602, 3615, 3699, 3713, 3724, 3737, 3747, 3751, 3771, 3786, 3802, 3818, 3828, 3838, 3848, 3858, 3867, 3890, 3939, 3953, 3964, 3974, 3993, 4002, 4080, 4099, 4115, 4123, 4136, 4142, 4150, 4152, 4159, 4165, 4174, 4181, 4182, 4184, 4227, 4228, 4230, 4232, 4236, 4237, 4303, 4308, 4309, 4314, 4316, 4318, 4319, 4351, 4377, 4379, 4394, 4405, 4417, 4428, 4432, 4442, 4446, 4452, 4461, 4565, 4572, 4641, 4650, 4806, 4954, 4968, 5025, 5028, 5281, 6217. **Paraneetroplus regani**: 1318, 1330, 1335, 1341, 1355, 1385, 1433, 1434, 1444, 1467, 1472, 1594, 1596, 1597, 1737, 1828, 1947, 2094, 2101, 2217, 2340, 2397, 2408, 2580, 2603, 2620, 2625, 2631, 2634, 2642, 2725, 2730, 2856, 2923, 3626, 3675, 3683, 3749. **Paraneetroplus melanurus**: 106, 1253, 1490, 1502, 1693, 1716, 1762, 1785, 1794, 2203, 2376, 2377, 2701, 2828, 2854, 2945, 2947, 2984, 3301, 3471, 3496, 3520, 3601, 3768, 3790, 3981, 4051, 4649, 5054, 6207. **Petenia splendida**: 110, 1204, 1248, 1281, 1381, 1382, 1489, 1501, 1522, 1536, 1545, 1625, 1644, 1660, 1670, 1695, 1711, 1729, 1735, 1746, 1757, 1761, 1772, 1774, 1791, 1797, 1807, 1826, 1833, 1845, 1848, 1850, 1867, 1871, 1877, 1898, 1906, 1913, 1916, 1951, 1976, 2024, 2028, 2039, 2053, 2072, 2084, 2088, 2149, 2151, 2153, 2170, 2210, 2214, 2220, 2230, 2240, 2248, 2520, 2525, 2529, 2538, 2549, 2571, 2578, 2590, 2602, 2770, 2778, 2785, 2786, 2814, 2825, 2835, 2841, 2847, 2850, 2861, 2867, 2877, 2881, 2909, 2918, 3144, 3147, 3242, 3270, 3455, 3479, 3492, 3573, 4104, 4161, 4170, 4231, 4235, 4388, 4395, 4410, 4430, 4436, 4440, 4451, 4463, 4464, 4547, 4907, 6202. **Rocio octofasciata**: 4326. **Theraps heterospilus**: 4830. **Theraps intermedius**: 4738, 4750, 4870, 4843, 4837, 4727, 4746, 4756, 4769, 4775, 4825, 4856, 4880, 4740, 4763, 4862, 4867, 6223. **Theraps lentiginosus**: 4845, 6222. **Theraps pearsei**: 104, 108, 109, 1284, 1366, 1408, 1520, 1534, 1628, 1651, 1681, 1690, 1739, 1745, 1764, 1780, 1787, 1837, 1858, 1891, 1964, 1984, 1992, 2006, 2016, 2022, 2054, 2070, 2155, 2180, 2201, 2378, 2396, 2431, 2516, 2607, 2659, 2668, 2676, 2692, 2796, 2836, 2866, 2953, 2981, 2986, 3002, 3300, 3521, 3527, 3533, 3546, 3565, 3567, 3572, 3600, 3706, 3720, 3789, 3793, 3821, 3843, 3865, 3966, 3973, 3978, 4011, 4083, 4097, 4682, 4722, 6655. **Thorichthys helleri**:

107, 1132, 1155, 1232, 1251, 1301, 1345, 1348, 1351, 1384, 1415, 1485, 1488, 1530, 1539, 1574, 1592, 1662, 1664, 1674, 1688, 1710, 1744, 1760, 1800, 1827, 1860, 1864, 1924, 1930, 1949, 1971, 1981, 2051, 2068, 2156, 2179, 2219, 2513, 2550, 2771, 2819, 2853, 2858, 2870, 2904, 2968, 3056, 3086, 3119, 3126, 3220, 3228, 3268, 3272, 3498, 3553, 3595, 3632, 3717, 3743, 3759, 3767, 3777, 3780, 3803, 3825, 3831, 3852, 3862, 3874, 3948, 3990, 4001, 4064, 4079, 4101, 4138, 4233, 4648, 4716, 4717, 4719, 4913, 4969, 5018, 6199. **Thorichthys meeki**: 6198. **Thorichthys pasionis**: 4341, 6197. **Thorichthys socolofi**: 4748, 4828, 4878, 4860. **Tilapia zillii**: 13, 1661, 1904, 2679, 2969, 3011. **Gobiomorus dormitor**: 4340.